Compressed Air Magazine

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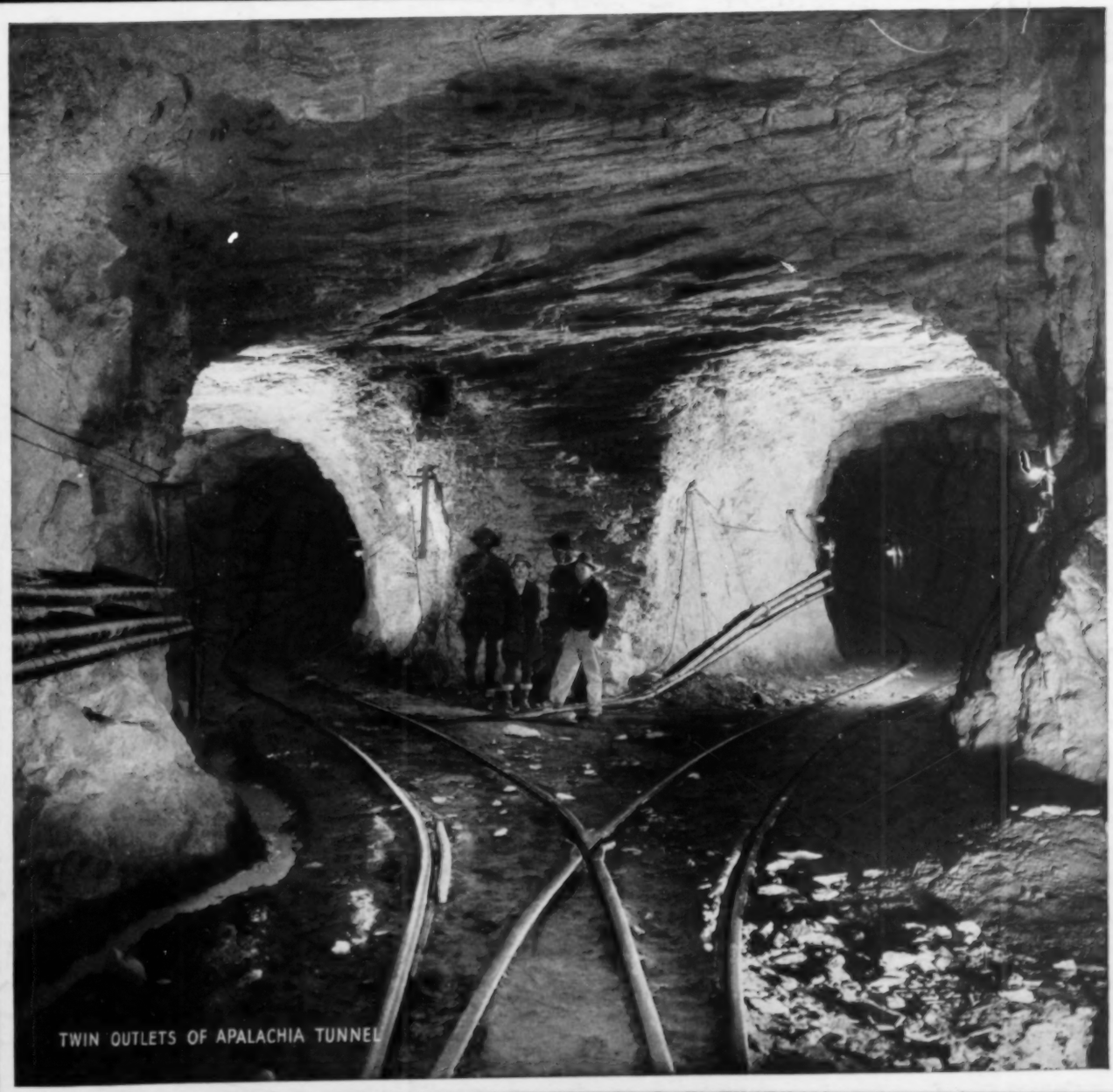
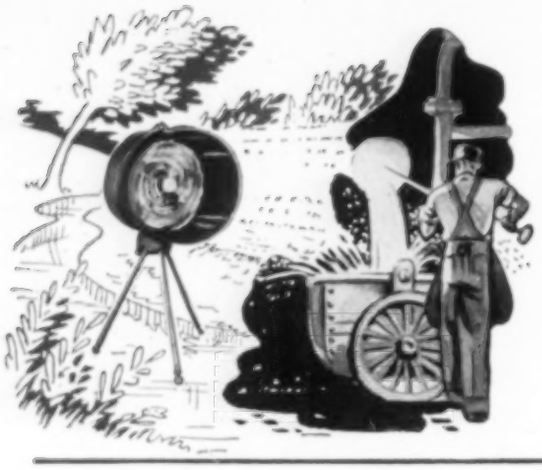


TWIN OUTLETS OF APALACHIA TUNNEL



BRING REFRESHING OUTDOORS INDOORS

Avoid the production slumps and poor work that always result from "hot weather fatigue." Men work better in moving air. Coppus Heat Killers move more air at less cost — direct the air onto the job — and prevent re-circulation of stale air. They are Coppus "Blue Ribbon" Products that can stand plenty of use and abuse.

COPPUS

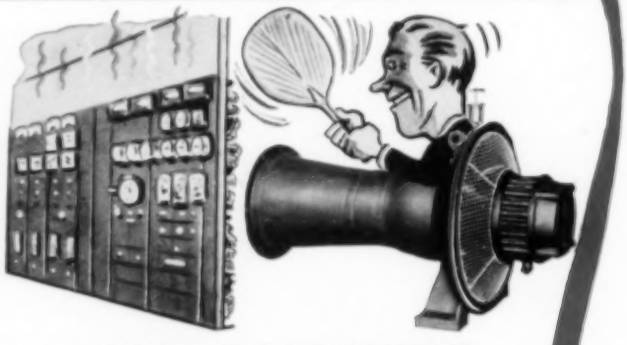
RUN . . . DON'T WALK . . . TO NEAREST EXIT

Noxious fumes and foul gases run away fast from a Coppus Cable Manhole and Tank Ventilator. Its powerful draft quickly clears the air in a tank or manhole — keeps fresh air circulating so men can work without discomfort. Large volume through small outlet. Usable anywhere. Look for the "Blue Ribbon!" That's the stamp of dependability you can *bank on*.

COPPUS

1001 USES

Two general types of Coppus Blowers and Exhausters — one for high velocities of air, the other for large volumes — have been modified many times for special purposes. Check off the applications which fit your needs, and have us send you specific information and prices.



DON'T LET EQUIPMENT GET "HOT-HEADED!"

Over-heated electrical equipment, like a hot-headed man, can cause a lot of trouble. Keep motors, generators and wires cool and on the job with Coppus Blowers! They supply the needed amount of cooling air at all times. Initial cost is moderate, and they are dependable as the famous "Blue Ribbon" indicates.

COPPUS

PLEASE SEND ME INFORMATION ON

Supplying Fresh Air to Men Working:

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ around cracking stills.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ supplying fresh air to storage tanks on tank farms.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.
- ☐ drying of walls, sheets, etc., after treated with coating material.

(Write below any special ventilating problem you may have.)

NAME .....

COMPANY .....

ADDRESS .....

CITY .....

MAIL THIS COUPON

To Coppus Engineering Corp., 245 Park Avenue, Worcester, Mass. Sales offices in Thomas Register. Other "Blue Ribbon" Products in Sweet's Catalog.

COPPUS "BLUE RIBBON" BLOWERS AND EXHAUSTERS

DESIGNED FOR YOUR INDUSTRY . . . ENGINEERED FOR YOU

"CHIEF, IT LOOKS AS THOUGH WE WON'T BE ABLE TO GET THAT NEW EQUIPMENT"
"THEN LET'S PLAN FOR MORE STAYNEW FILTERS TO KEEP OUR PRESENT EQUIPMENT AT PEAK EFFICIENCY"

Check Your Needs Now FOR STAYNEW FILTERS

Not only are many suppliers unable to deliver new equipment, but nowadays competent repair service is often unavailable. Present equipment must be made to last. One of the best ways to assure its continuous, repair-free operation is to protect it with Staynew Filters.

Staynew builds filters for your compressor and engine protection, pipe lines, building ventilation, air, gas, and liquids. Sizes and styles are made for nearly every requirement. If necessary, Staynew engineers will adapt present models or design new ones for your special needs. "Keep 'Em New" with Staynew Filters.

Write for catalog today, and find out how your equipment can be made to last longer and operate more efficiently when Staynew Filter-protected.

COMPRESSOR INTAKE

Model D

Air drawn into intakes of Diesels and other internal combustion engines and compressors must be clean. Dust scores cylinder walls, causes valves to stick and burn, forms excessive carbon, wears all moving parts. Model D Filters featuring famous radial fin construction are the most efficient ever designed for intake use. No damage to engine or compressor due to intake of foreign matter can result even though the Model D Filter is improperly serviced. Being dry-type Model D's are particularly adapted for use with carbon ring compressors. They are not affected by atmospheric changes of temperature or humidity.

PIPE LINE

Model CPHS

Dust, dirt, moisture, and pipe scale in air and gas lines cause damage to air-powered tools and to many processes. Foreign matter in liquid lines (for oil, water, acid, etc.) may cause excessive wear, prevent proper reactions. Models CP, CPH, CPHS, CPHLS, and AAPHS guard innumerable machines and operations. Featured radial fin construction permits high filtering efficiency, low restriction to flow.

BUILDING AND ENGINE ROOM VENTILATION.

Automatic

Employee health, as well as the proper operation and protection of much vital equipment, depend on clean air. Motors, transformers, turbo generators, etc., must be supplied with dust-free air. Staynew Automatic Filters deliver large volumes of clean air at low cost.

Panel Filters (below, left) offer highest possible efficiency with low restriction to air flow. Wire-Klad Filters (below, right) feature low initial cost, long life and fire resistance.

PANEL

Intake Side

WIRE-KLAD

Outlet Side

STAYNEW FILTER CORP.

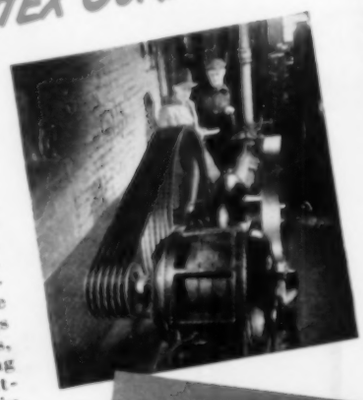
"Filter Headquarters"

PROTECTOMOTOR AIR FILTERS

7 Centre Park, Rochester, N. Y.

The Dayton Thorobred V-Belt

With a Fighting Heart of Daytex Cord —



Sleek, black and harmonizing with the color of all machinery, the Dayton Thorobred Wrapped-Moulded type V-Belt conforms to all the requirements of the National Rubber Conservation Program. More than that, it has been engineered for all-out duty—with Dayton's basic and original patented principle of 3 prime sections. The result is a V-Belt whose life is 41% longer, by actual tests, than the average of 4 leading makes—a V-Belt with a fighting heart of Daytex Cord in its neutral section—a V-Belt tested and proved in hundreds of field applications.

THE DAYTON RUBBER MFG. CO.
Dayton, Ohio

DAYTON RUBBER EXPORT CORP.
38 Pearl Street, New York, N. Y., U. S. A.

THE WORLD'S LARGEST MANUFACTURER OF V-BELTS

BELT-LIFE COMPARISON CHART

DAYTON THOROBRED	
BELT "2"	
BELT "3"	
BELT "4"	
BELT "5"	

This chart of tests operated under identical conditions as to size, load, speeds, tension, pulley diameters and ambient temperatures, shows:

The Dayton Thorobred Gives 28% Longer Life than the next best belt and 41% Longer Life than the average of the 4 belts tested.

41% LONGER LIFE
(BY ACTUAL TESTS)
THAN THE AVERAGE LIFE OF 4 LEADING BELTS

Dayton's 3 Prime Sections

Under the tough, rugged black cover which resists dust, moisture and other elements, are Dayton's 3 prime sections.

1. THE TENSION SECTION—Live, heat-resistant rubber compounds provide the "give" necessary to efficient and cooler-running performance.

2. THE DAYTEX CORD NEUTRAL SECTION—The fighting heart of the Thorobred—famed Daytex Cord imbedded in strong, live rubber compounds.

3. THE COMPRESSION SECTION—Fibres run crosswise to achieve great cross-sectional rigidity, less distortion in pulley grooves.

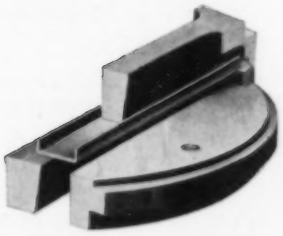
Dayton V Belts

LIFELINES OF POWER VITAL TO VICTORY

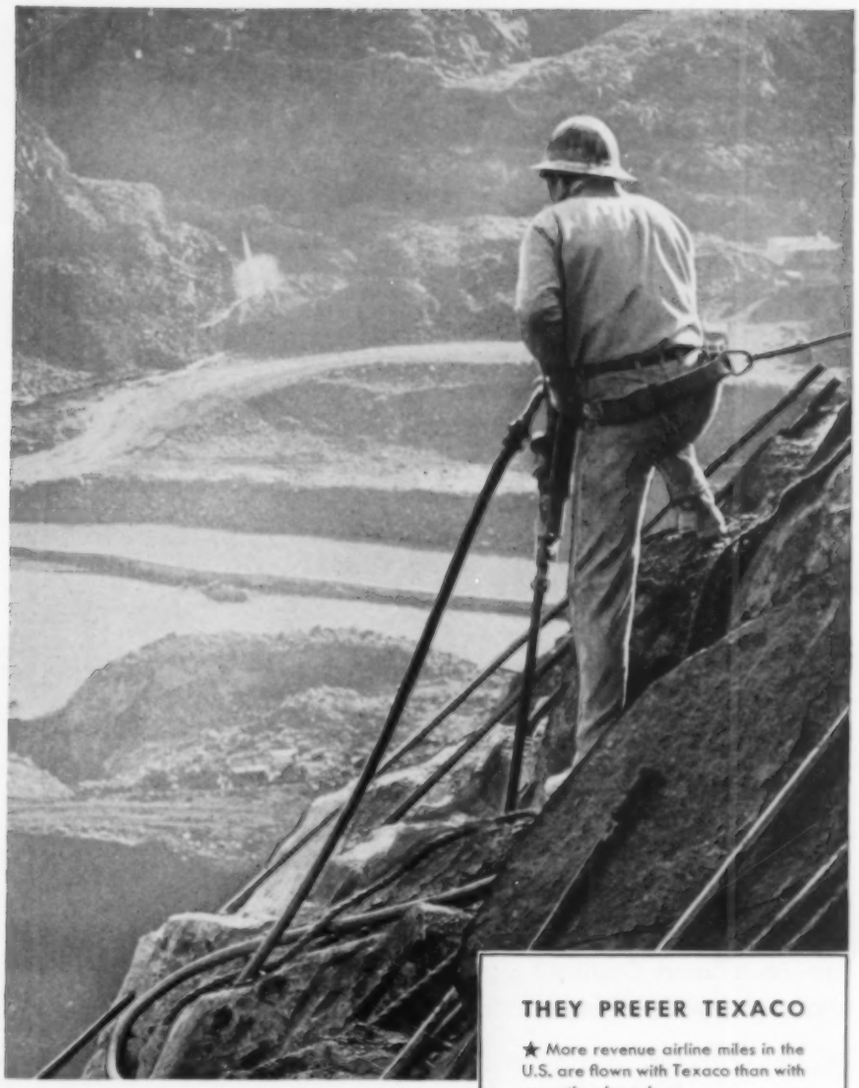
THE GREATEST NAME IN V-BELTS

Copyright, 1942, The Dayton Rubber Mfg. Co.

More Air through CLEANER VALVES



Cutaway Section of I-R Channel valve. Keeping compressor valves free from carbon is a job for the lubricant. Compressors stay clean, efficient when lubricated with TEXACO.



Your compressors will work more efficiently when the valves are kept continuously clean . . . by using *Texaco Alcaid, Algol or Ursa Oils.*

Free from elements that form gum, sludge and hard carbon, these Texaco oils maintain wide-opening, tight-shutting valves, free piston rings, clean air lines.

The outstanding performance that has made Texaco preferred in the fields listed in the panel has made it preferred by prominent compressor operators everywhere.

These Texaco users enjoy many benefits that can also be yours. A Texaco Lubrication Engineer will gladly cooperate . . . just phone the nearest of more than 2300 Texaco distribution points in the 48 States, or write: The Texas Company, 135 East 42nd Street, New York, N. Y.

Care for your Car ..for your Country

THEY PREFER TEXACO

★ More revenue airline miles in the U.S. are flown with Texaco than with any other brand.

★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and cars in the U.S. are lubricated with Texaco than with any other brand.

FOR YOUR ENJOYMENT

FRED ALLEN every Sunday night. See your local newspaper for time and station.

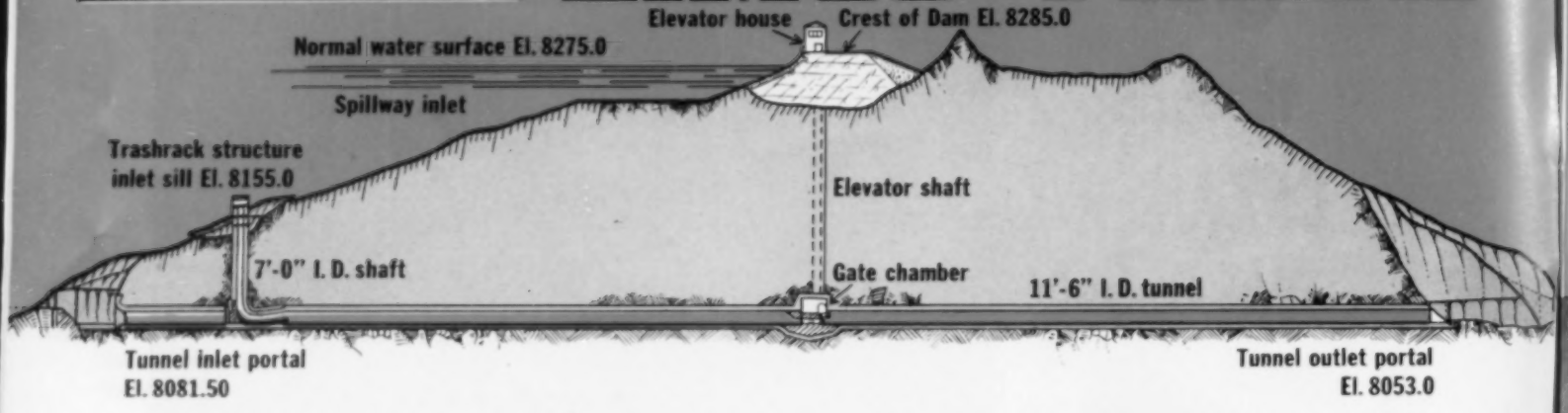
TEXACO

TEXACO Lubricants

FOR ALL COMPRESSORS AND AIR TOOLS

HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

Mucking out the Granby with an EIMCO-FINLAY



Having completed their 8000-ft. contract in the West Portal of the Continental-Divide Tunnel, Platt-Rogers, Inc. are now using their same two Model 21 Eimco-Finlay Loaders to muck out the 1067-ft. Granby Dam Diversion and Outlet Tunnel shown in the accompanying illustrations.

Being 14 ft. in diameter—on a 3% rising grade—the Granby-Dam Tunnel is more of a job to muck out than the 12′ x 12′ Continental-Divide Tunnel was, but Mr. F. A. Huntington, Tunnel Superintendent, says, "The loaders are performing excellently."

At the time the accompanying photographs were taken the tunnel had been advanced 278 ft., at an average rate of 20 ft. per two-shift working day—which is considered very satisfactory in view of the fact that the rounds are restricted to approximately 5-ft. in order to minimize over-breakage and avoid shattering the surrounding rock.

On this job, as on many other recent tunnel jobs throughout the United States and other countries, the Model 21 Eimco-Finlay Loader has demonstrated its superiority so convincingly that no one familiar with the facts would consider using any other type of mucking machine for similar service. Its distinctive, patented, rocker-arm mucking action; simple, sturdy, all-steel construction and absolute freedom from trouble-making "gadgets" of any kind enable it to slash through the toughest muck piles, mile after mile, without injury to any important part, and with amazingly little expense for general operation and upkeep.

Bulletin 105 (36 large fully-illustrated pages) gives complete information regarding design, construction and operation of the Eimco-Finlay Loader. Write today for free copy, or use the convenient coupon.

THE EIMCO CORPORATION, Salt Lake City, Utah, U. S. A.

I am interested in mechanical loading and would like to receive a copy of Bulletin No. 105 with the understanding that no charge or obligation of any kind will be incurred.

Name_____

Position or Title_____

Company_____

Address_____

OUR GUARANTEE

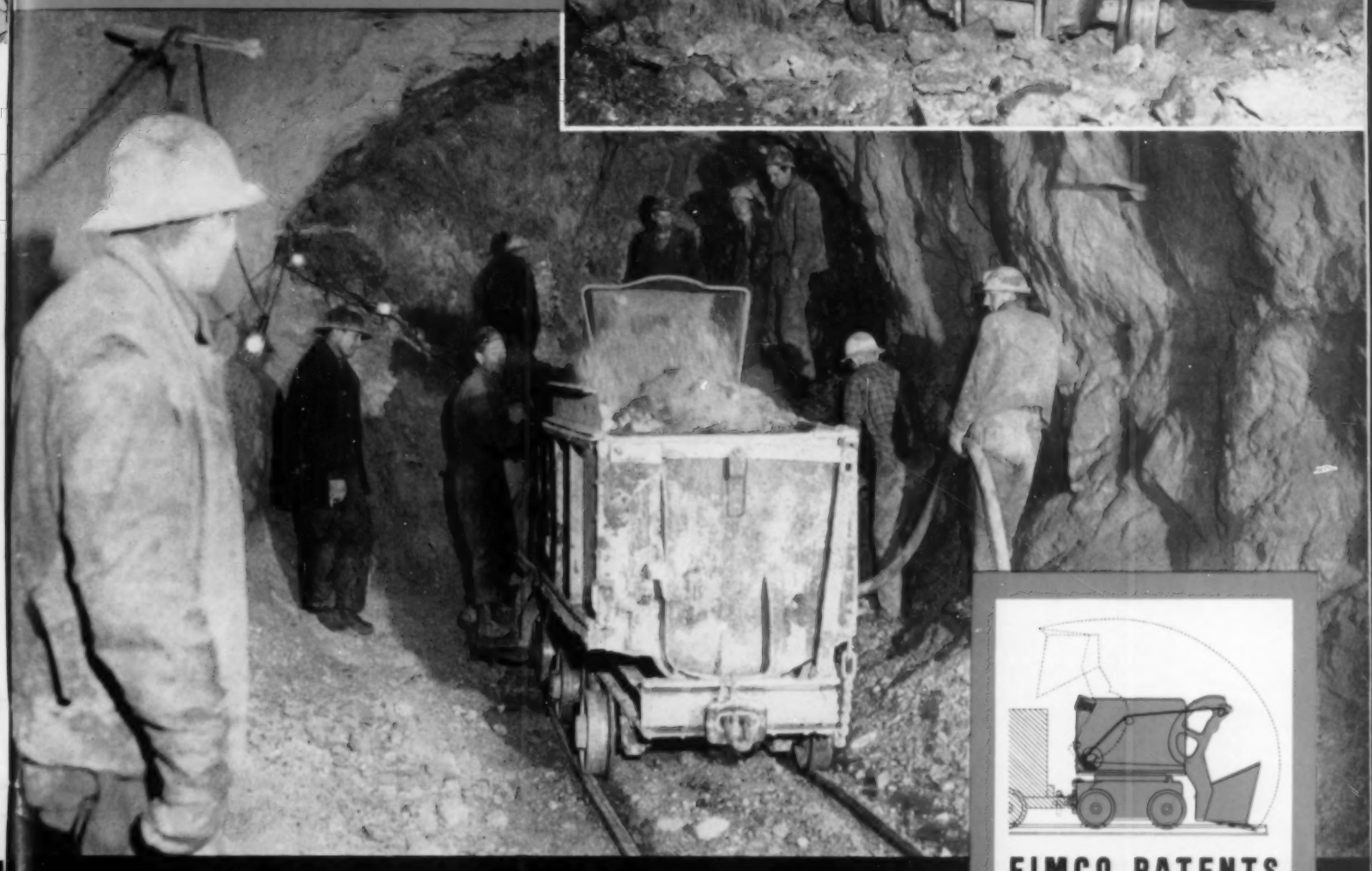
Year after year, far more Eimco-Finlay Loaders are manufactured and sold than all competitive types combined, and their inherent superiority has been so thoroughly proved that every machine sold now carries a positive money-back guarantee that it will outlast and out-perform any other mucking machine of comparable size and type at any air pressure, and under any working condition.

Dam Tunnel..

LOADER

LEFT: Profile showing Granby-Dam Diversion and Outlet Tunnel. Diameter of tunnel after lining with steel and concrete will be 11'-6".

RIGHT: Model 21 Eimco-Finlay Loader filling 54 cubic foot Koppel car in 14-ft. diameter Granby-Dam Tunnel.



EIMCO PATENTS

give exclusive rights to the use of any rocker-arm profile other than a segment of a true circle and to the use of any rocker-arm which rolls on a supporting track or bed. No other known method for controlling the action of a mucking machine permits such simple sturdy construction or gives such high operating efficiency.

THE EIMCO CORPORATION

SALT LAKE CITY, UTAH, U.S.A.

NEW YORK, 120 Broadway
EL PASO, Mills Bldg.
CHICAGO, 111 W. Washington St.
SACRAMENTO, 1217 7th St.

INGERSOLL-RAND CO., LTD.
165 Queen Victoria St., London

BRITISH MIN. SUP. CO. (PTY.), LTD.
Troye House, Johannesburg, S. A.

HODGSON & CRANSTON
Boulder Road, Kalgoorlie, Aust.

DOMINION CONSTRUCTION CO., LTD.
Wellington, New Zealand

MINE EQUIPMENT COMPANY LTD.
Kirkland Lake, Ontario, Canada

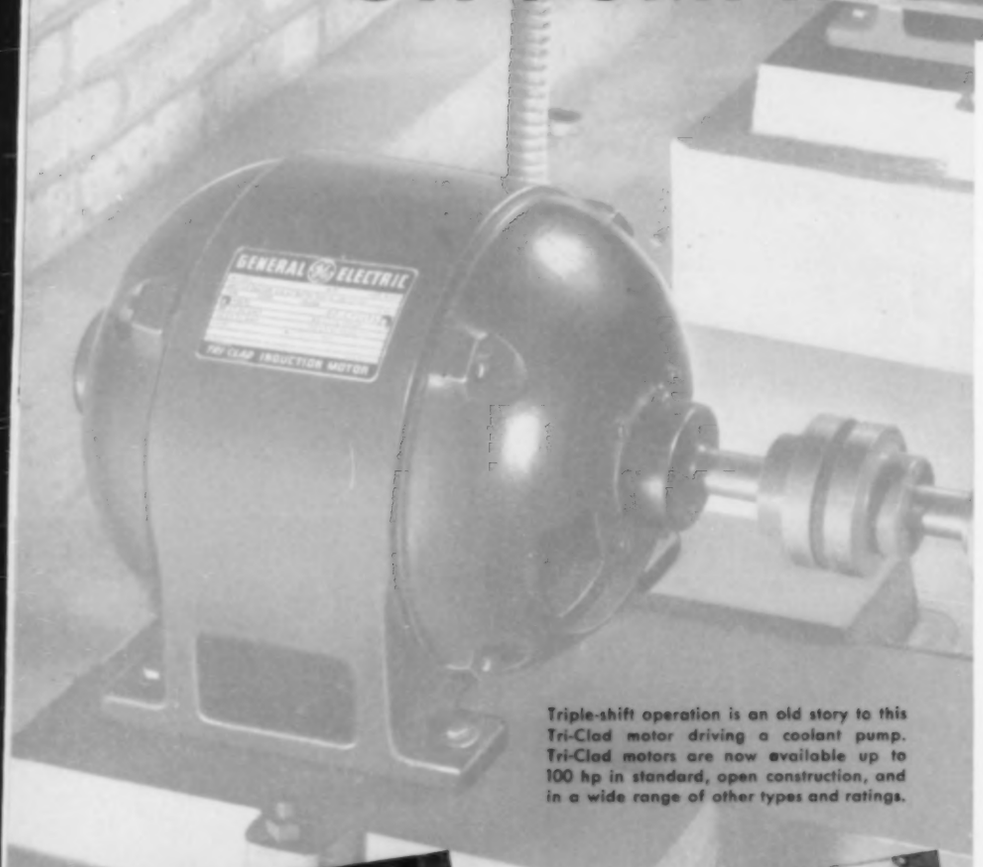
B. C. EQUIPMENT CO., LTD.
551 Howe St., Vancouver, B. C.

MARSMAN TRADING CORPORATION
Manila and Baguio, Philippine Is.

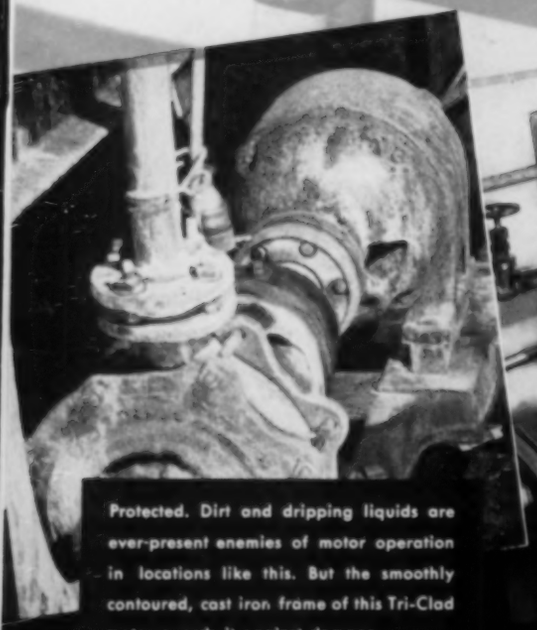
INTERNATIONAL MACHINERY CO.
Rio de Janeiro, Santiago and Antofagasta

MORE "STAYING POWER"

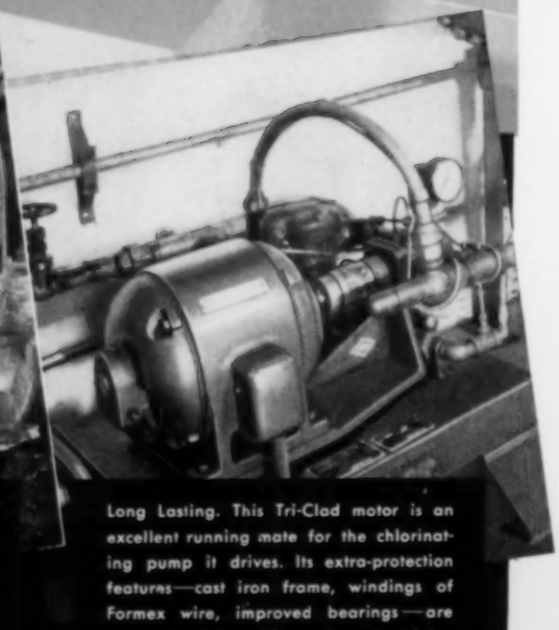
ON PUMPING JOBS



Triple-shift operation is an old story to this Tri-Clad motor driving a coolant pump. Tri-Clad motors are now available up to 100 hp in standard, open construction, and in a wide range of other types and ratings.



Protected. Dirt and dripping liquids are ever-present enemies of motor operation in locations like this. But the smoothly contoured, cast iron frame of this Tri-Clad motor guards it against damage.



Long Lasting. This Tri-Clad motor is an excellent running mate for the chlorinating pump it drives. Its extra-protection features—cast iron frame, windings of Formex wire, improved bearings—are assurance of long life on important jobs.

BUILT FOR PROTECTION FIRST..TO LAST

The extra protection of TRI-CLAD MOTORS helps keep pumps delivering

NOW—before you buy motors—is the time to solve your pump-motor problems. Wherever continuous pumping is essential to your production—wherever pumps must operate under adverse conditions—your motors must be secure against 1) physical damage, 2) electrical breakdown, 3) operating wear and tear.

Here's where the *extra*-protection features of Tri-Clad motors will help you get the triple-shift operation you need. Their cast-iron frames and end shields exclude falling objects and dripping liquids; their windings, of Formex wire, are resistant to oil, moisture, and heat shock; their improved bearings, completely sealed in cast iron, are protected against the entry of dust and dirt. All these features add up to *extra staying power* on jobs where 24-hour production is essential.

How to Get Motors Quicker

USE STANDARD MOTORS. Wherever possible, select standard, open, sleeve-bearing motors. Building fewer "specials" means faster and greater production of motors for war work.

PLACE ORDERS EARLY. Order the motors when you order, or plan for, the equipment they are to drive.

SEND PROPER PRIORITY. Be sure correct priority papers accompany your order and that the priority rating reflects the urgency of the motor's use in the war.

CHECK G.E. for warehouse stocks. A supply of many standard motors are kept on hand to meet urgent war needs. Perhaps the motor you want, or can use with a few simple changes, is available for immediate shipment.

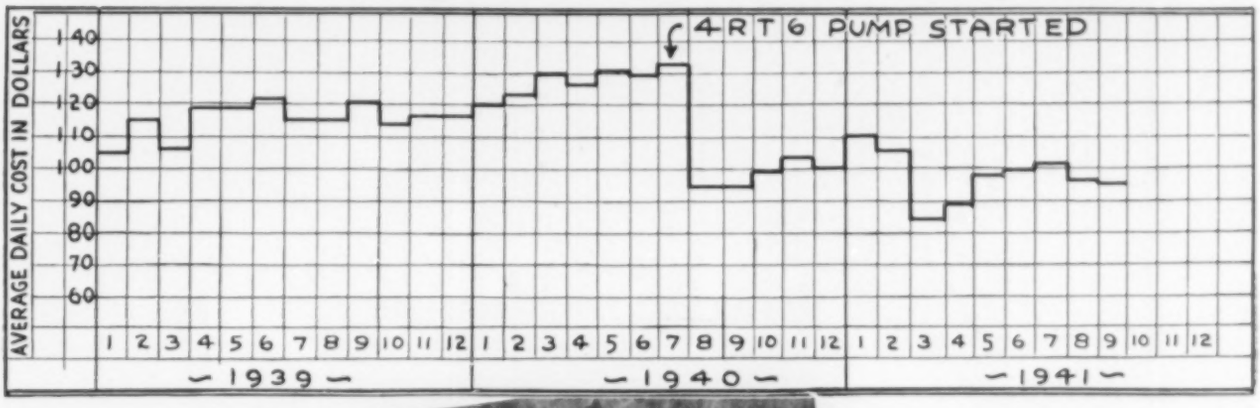
General Electric, Schenectady, N. Y.

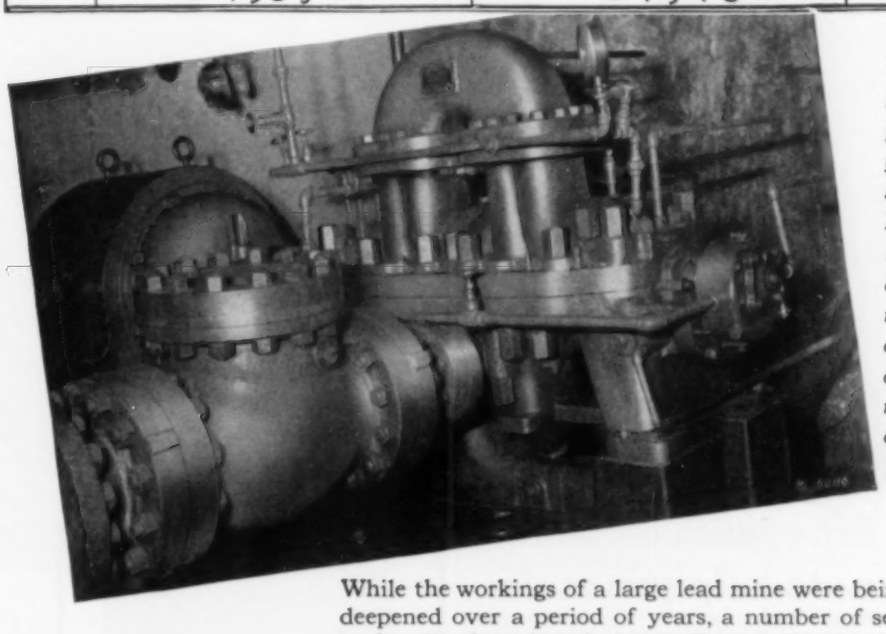
General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.

GENERAL ELECTRIC

700-107-8030

Lead Mine Saves $20 A Day with *New* Ingersoll-Rand Pump





The 4-inch, 6-stage Ingersoll-Rand Type RT pump which paid for itself in less than a year by reducing power consumption. This unit delivers 750 gal per min against a 1750-ft head and is driven by a 500-hp motor. The ruggedness, high efficiency, great accessibility, and balanced rotor construction of these pumps make them particularly suitable for mine service.

While the workings of a large lead mine were being gradually extended and deepened over a period of years, a number of series pumps were installed to handle the mine drainage. Eventually the mine developed to a stage where this system was no longer the most economical method.

Ingersoll-Rand engineers recommended that all of these series pumps be replaced by a single high-head unit. A 4-inch, 6-stage, 500-hp Type RT pump was selected and it went into operation on August 1, 1940.

The average daily power cost for pumping during the first month of service was $38.00 below similar costs for the previous month. Since then, the average daily saving has never been less than $10.00, and, on occasion, it has been as much as $43.00. The power saving during the first year of its operation more than paid for this new pump, and during all of this period the new RT-6 pump has handled more water at higher head than the total of the replaced series units.

Perhaps you, too, have some pump installation that should be investigated. Let our engineers help you. There is no obligation.

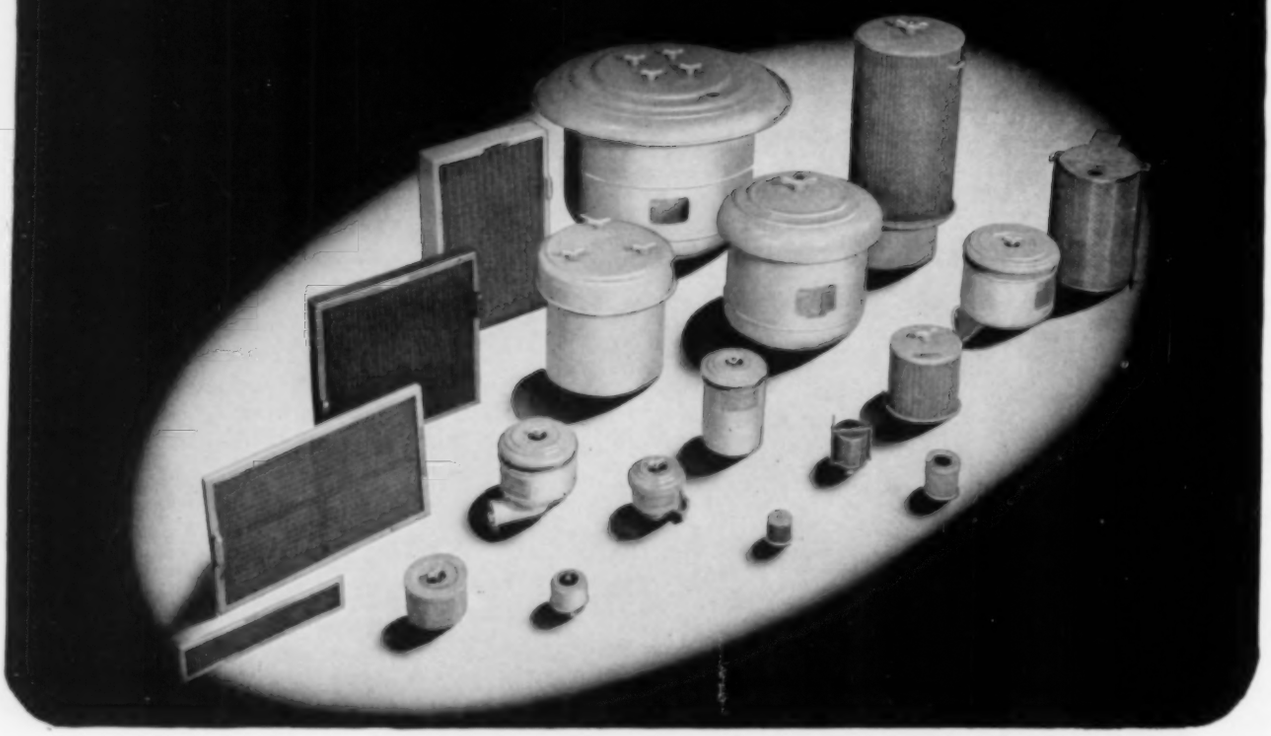
Ingersoll-Rand

CAMERON PUMP DIVISION

11 BROADWAY, NEW YORK, N. Y.

10-161

IF IT'S AN AIR FILTER PROBLEM AIR-MAZE ENGINEERS WILL SOLVE IT!



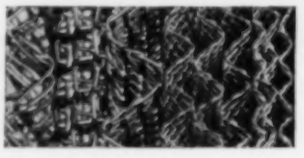
Our Specialized Experience of nearly 20 years is Yours—to help you make your Present Equipment last longer

● The photograph above shows only a few of the 3,000 different types and sizes of air filters which AIR-MAZE engineers have designed for almost every field of application.

This *specialized* engineering experience is a part of every air filter we produce. It is yours at no extra cost when you specify "AIR-MAZE."

Whether your air filter problems involve engines, compressors, blowers or air-conditioning, be sure to ask AIR-MAZE engineers *first*. Their experience can help you improve performance, lower maintenance costs and prolong the life of your vital equipment. Write for complete information.

AIR-MAZE CORPORATION • General Offices, Cleveland, Ohio



ONLY AIR-MAZE HAS THIS PATENTED FILTER MEDIA

Scientifically designed and precisely arranged "maze" of crimped round wire utilizes the "baffle-impingement" principle to the highest degree. Provides highest efficiency with extremely low pressure drop. Cleanable. All metal. Nothing to wear out.

AIR-MAZE

DEPENDABLE AIR FILTERS FOR EVERY APPLICATION

When Little Things Loom Big··· by Alexander

PACKING RINGS, TOO, are one of those "tremendous trifles" that influence people. Mrs. O'Reilly, for instance, doesn't know a packing ring from a gas holder but there'll be the devil to pay if the gas pressure plays tricks with her pot of potatoes. And if the jack hammer Mr. O'Reilly wields every day suddenly stops breathing, heaven help the sinning compressor. No engine or compressor manufacturer, no user can afford the consequences of improperly specified, poorly designed or carelessly made packings—especially since the cost of good France packing is a drop in the bucket compared with the cost of delays, breakdowns, scored rods or cylinders.

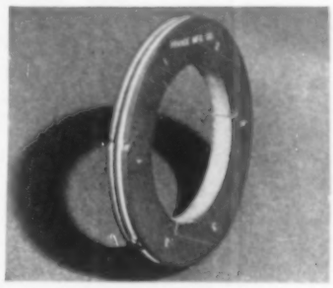
France makes regular packings for usual conditions but is better known for its cooperation with industries in the development of special packings. From this cooperation have come packings for safely handling synthetic, poisonous and inflammable gases—for vacuums or pressures up to 15,000 lbs.

If you have a regular or a new job for packing, let France help you.

PACKINGRAM

by

E. A. FRANCE



CARBON-BAKELITE

Packing and Piston Rings

Carbon-Bakelite Packing and Piston Rings give outstanding service in natural gas compressors. They have proved equally satisfactory in compressors for many other gases, notably propane, butane, methane, still gas and others of the hydro-carbon series. They are chemically immune to the effects of "sour" gas.

Carbon-Bakelite is a phenol-formaldehyde product containing a high percentage of fine carbon particles, laminated with duck and bonded under heat and tremendous pressure. It is a hard, dense, durable, non-metallic substance, light in weight, resistant to corrosion. Carbon-Bakelite possesses a very low coefficient of friction and strongly resists wear. The carbon content greatly improves the wearing and bearing qualities of the Bakelite.

Carbon-Bakelite, used for packing or piston rings, produces a high polish on the rod or cylinder. Rings made of it will out-wear metal rings in gas service. They wear especially well on sprayed-metal rods. The ring retaining grooves show no appreciable sign of wear. This is due to the fact that the rings, being much lighter than metal, cause no hammering effect on the groove walls when the stroke is reversed.

The France Manufacturing Company furnishes Carbon-Bakelite packing rings in cases of their own manufacture to fit any compressor stuffing box, or rings will be furnished to fit any make of packing case now in service.

France Carbon-Bakelite piston rings are made with a step joint, sealed from the back by the cast iron expander, to prevent by-passing of gas. Three-piece segmental, step-joint rings are also supplied.

Specification blanks for ordering any of the products above are available promptly upon request.

Complete line of packing for all gases up to 15,000 lbs. pressure, as well as for superheated steam engines and gas engines.

FRANCE MFG. CO.

FRANCE MANUFACTURING COMPANY

Belgrade and Orthodox Streets • Philadelphia, Penna.

"Don't Take A Chance—Take FRANCE"

. . . With Your Ideas on Ways to
SPEED PRODUCTION *with* COMPRESSED AIR

Here's how you can contribute IDEAS to help win the war.

DO THIS: Describe some application of compressed air which speeds production (in your own experience or observation). The IDEA counts—not the grammar. Simple rules mailed on request.

YOUR OPPORTUNITY to pass along ideas which will speed up production and help win the war. Substantial cash prizes offered. Prize-winning papers will be brought to attention of your industry, giving recognition and prestige to the authors. All entries of value to the war effort, whether they are prize-winners or not, will be offered to the proper United States Agency with full credit to the writer.

PRIZES DOUBLED. Because of increased importance of compressed air in the war effort, prize awards as originally announced, have been doubled, and closing date has been extended to July 1, 1942.

ATTENTION EXECUTIVES. Posters announcing this IDEA Award Program are available to enable you to bring this project to the attention of your engineers and shop men. Free on request.

All requests for Rules and Posters should be addressed to Russell Gross, Educational Director, Compressed Air Institute, East Orange, New Jersey.

★ ★ ★ ★ ★ ★ ★ ★

$1000.00 IN CASH AWARDS

FIRST PRIZE $200.00 — THREE PRIZES OF $100.00

TEN PRIZES OF $50.00 — SPECIAL AWARDS $25.00 EACH

For every non-prize winning entry which is accepted for publication in a technical journal, at the request of the Compressed Air Institute.

plus

PERSONAL PRESTIGE and RECOGNITION

Uncle Sam Needs Your Ideas

HERE'S HOW YOU CAN HELP

Describe compressed air applications in your own experience or observation, which speed up production. The IDEA will be passed along to help the war effort. Write today for details.

This announcement appears here through the courtesy of

INGERSOLL-RAND CO., 11 BROADWAY, NEW YORK

COMPRESSED AIR INSTITUTE..
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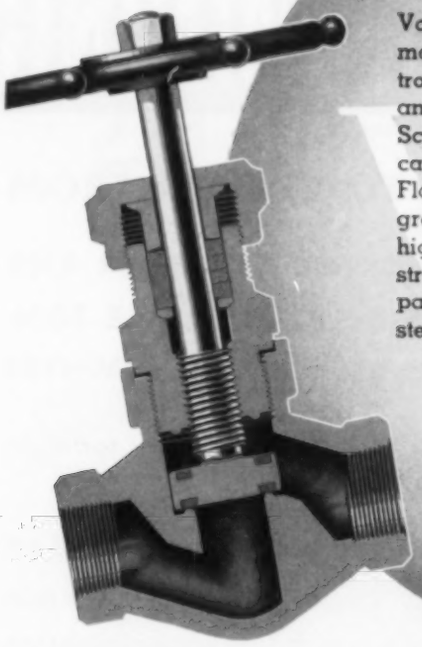
DROP FORGED STEEL AND SEMI-STEEL VALVES FOR ICE MAKING AND REFRIGERATING PLANTS!



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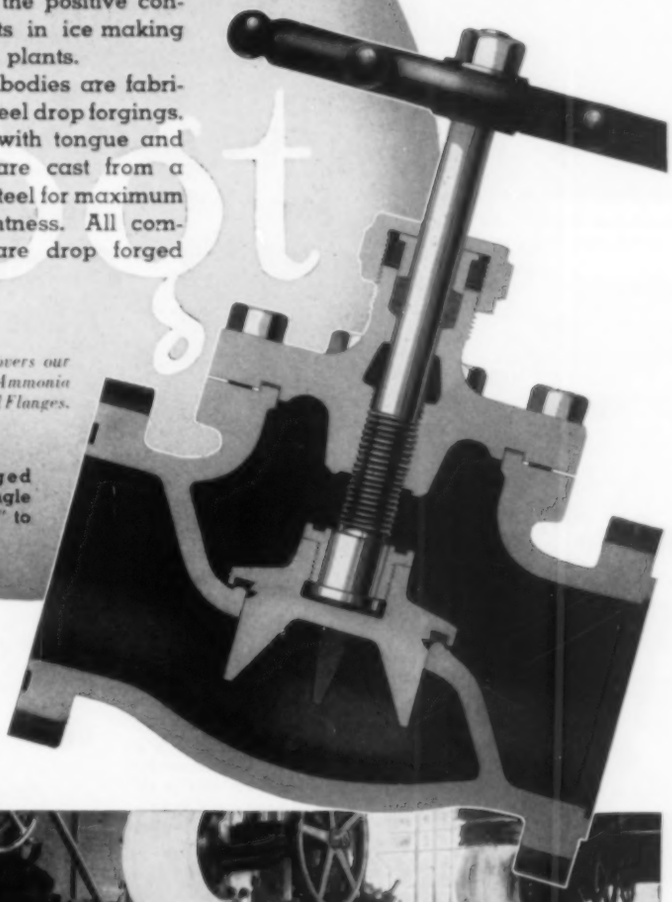

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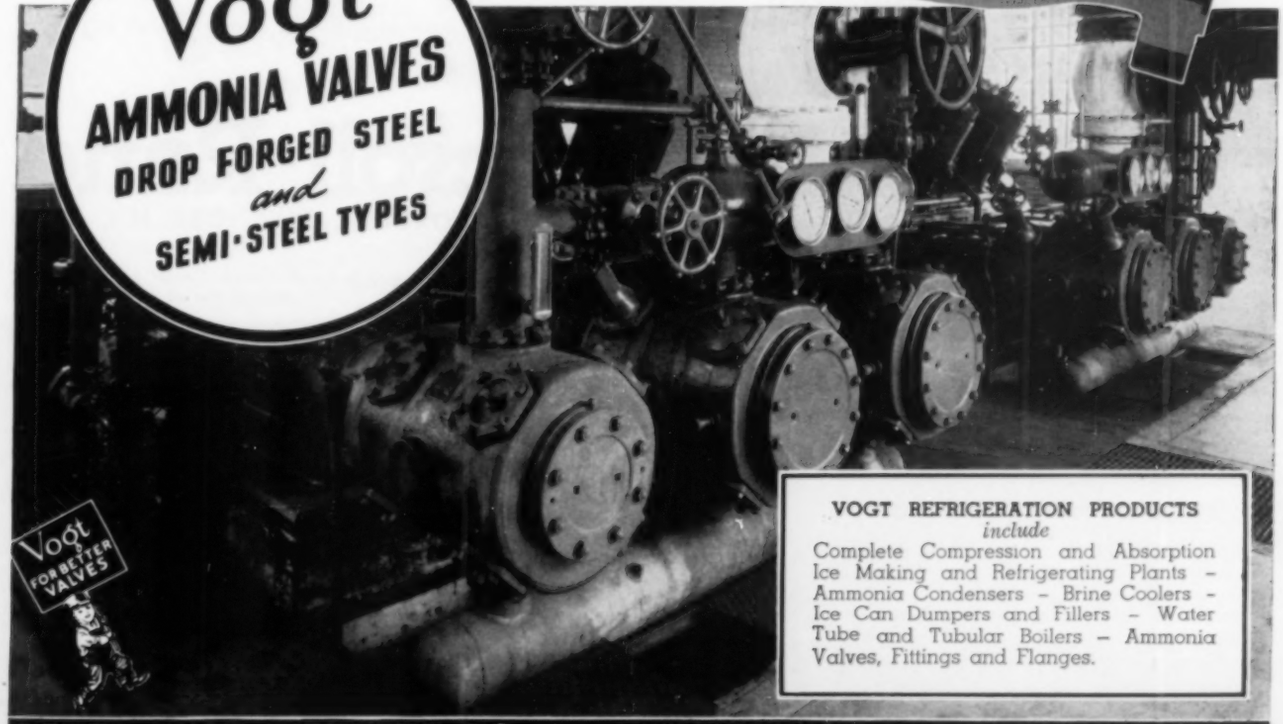

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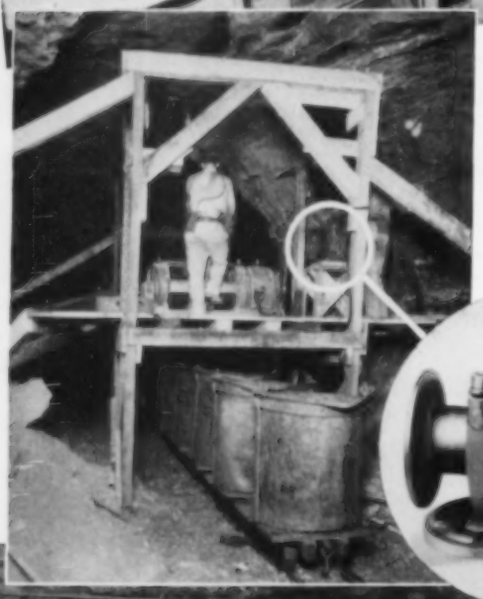
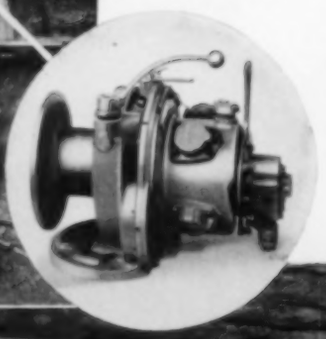


Double-drum electric "Tugger" hoist operating in a lead-zinc mine. Also note the "Utility" air hoist at the right which is used for pulling empty cars under loading platform.



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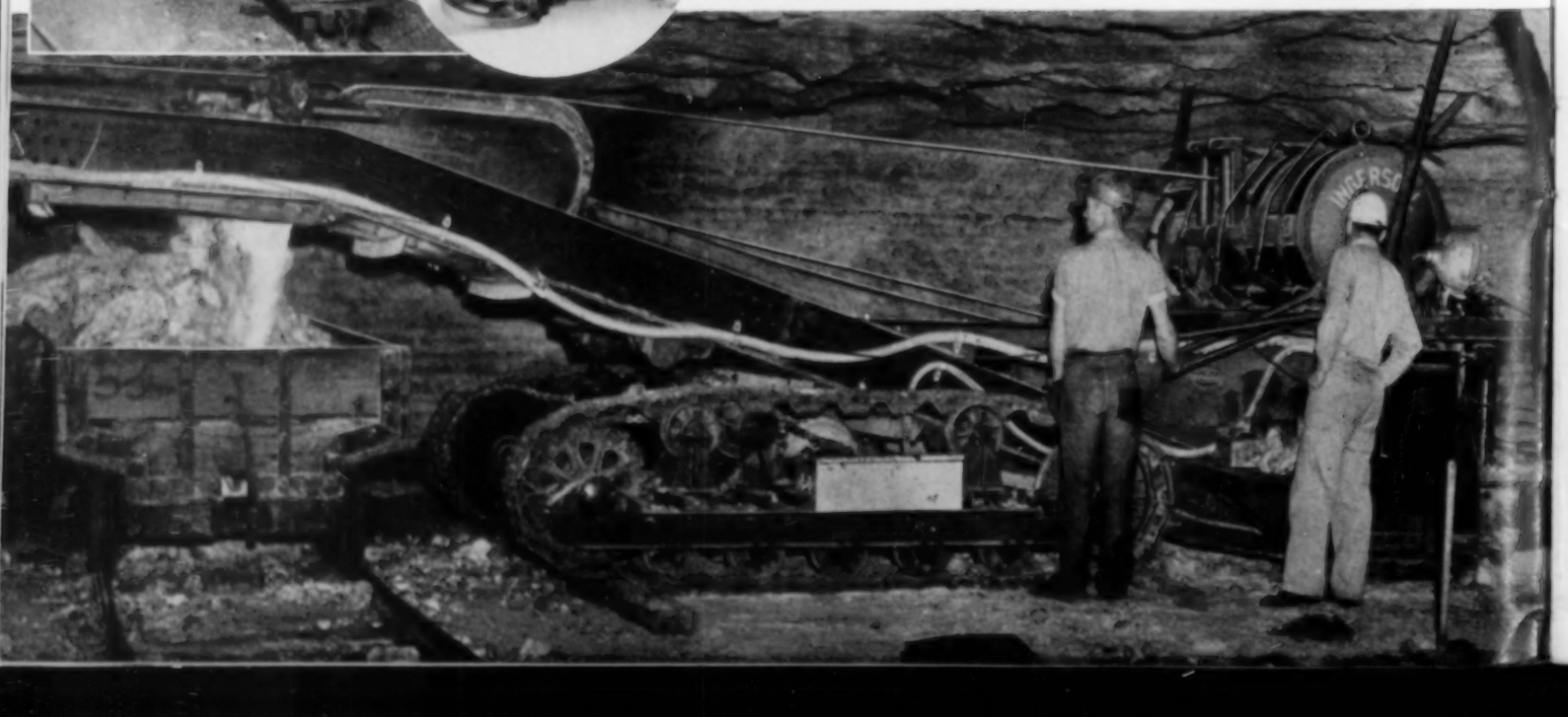

A 50-hp three-drum electric "Tugger" hoist on caterpillar mounting in a salt mine.

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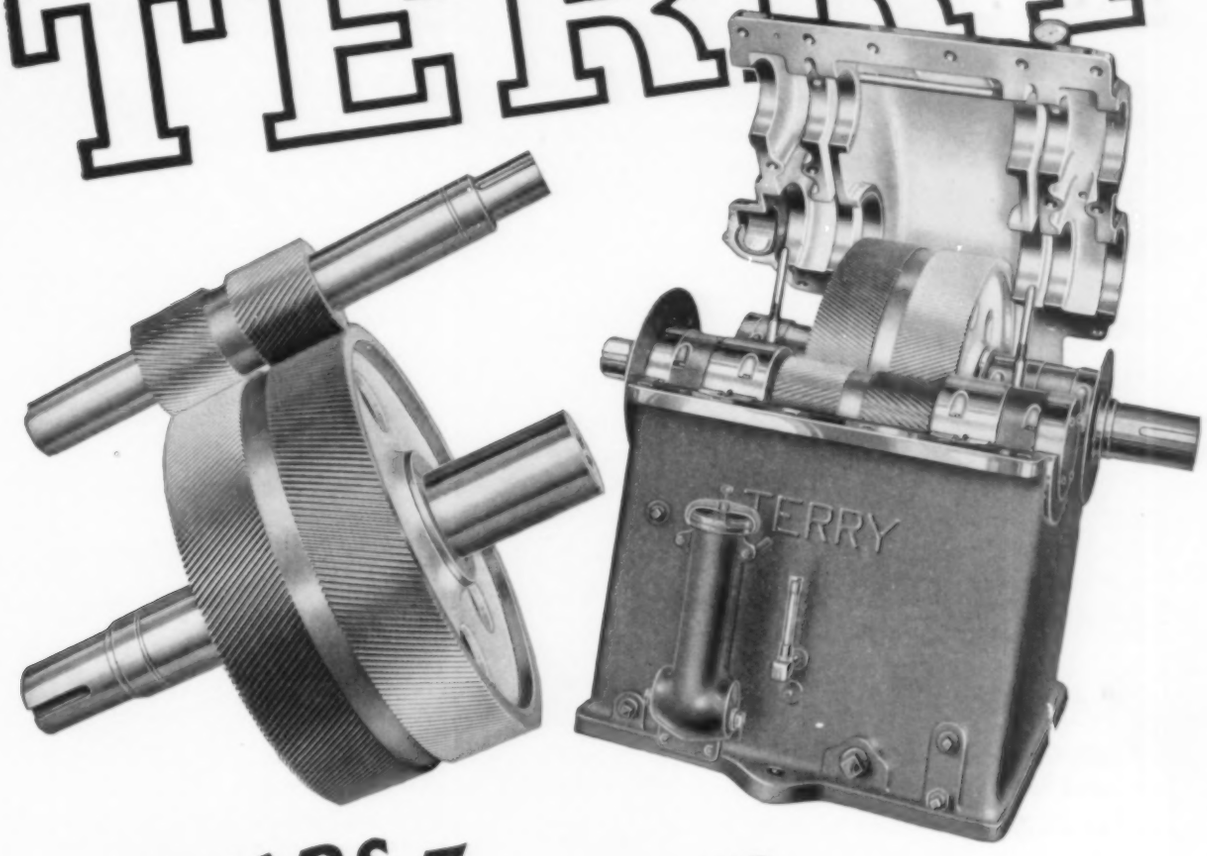

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ON THE COVER

OUR cover picture was taken in the Apalachia Tunnel, which is described in our first article. At the point shown, which is near the downstream end of the tunnel, the 20-foot bore divides into two 14-foot sections leading to the penstocks through which the water will drop 216 feet to the powerhouse turbines. In the picture are Frank J. Kish, TVA tunnel engineer, and Roy Kees, assistant tunnel superintendent. The photograph was taken by Richard T. Jackson.

•

IN THIS ISSUE

THE Apalachia Project on the Hiwassee River is the first undertaking of the Tennessee Valley Authority that involves extensive tunneling. Because of the importance of starting power generation as soon as possible, the 8-mile bore was laid out so that work could be conducted simultaneously at one end and at four intermediate points. Rapid progress is being made, and the final section will be holed through sometime next fall. Our leading article, which is the second in a series on current TVA activities, describes all phases of the $50,000,000 project.

•

SALT, which is plentiful in America and scarce in some parts of the globe, is the subject of our second article. Salt has grown from an article of household use to an important raw material for the chemical industry. From it are derived numerous products that affect our daily lives.

•

ALMOST everybody nowadays "reads" pictures and many magazines do a good job of printing them. Lots of times they get valuable assistance from a photo-retoucher, whose little-known work is described in a short article by J.F. Nesbitt. The author is responsible for the layout and artwork of this publication.

•

A SHORT article tells how the Government built homes for 3,000 families of workers in aircraft plants on the Pacific Coast at a cost of $3,000 per unit.

•

THE narrative *Let's Go Fishing* should have a wide appeal at this time of the year. It is true, of course.

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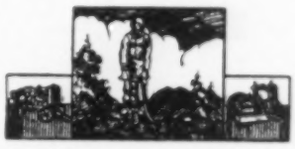

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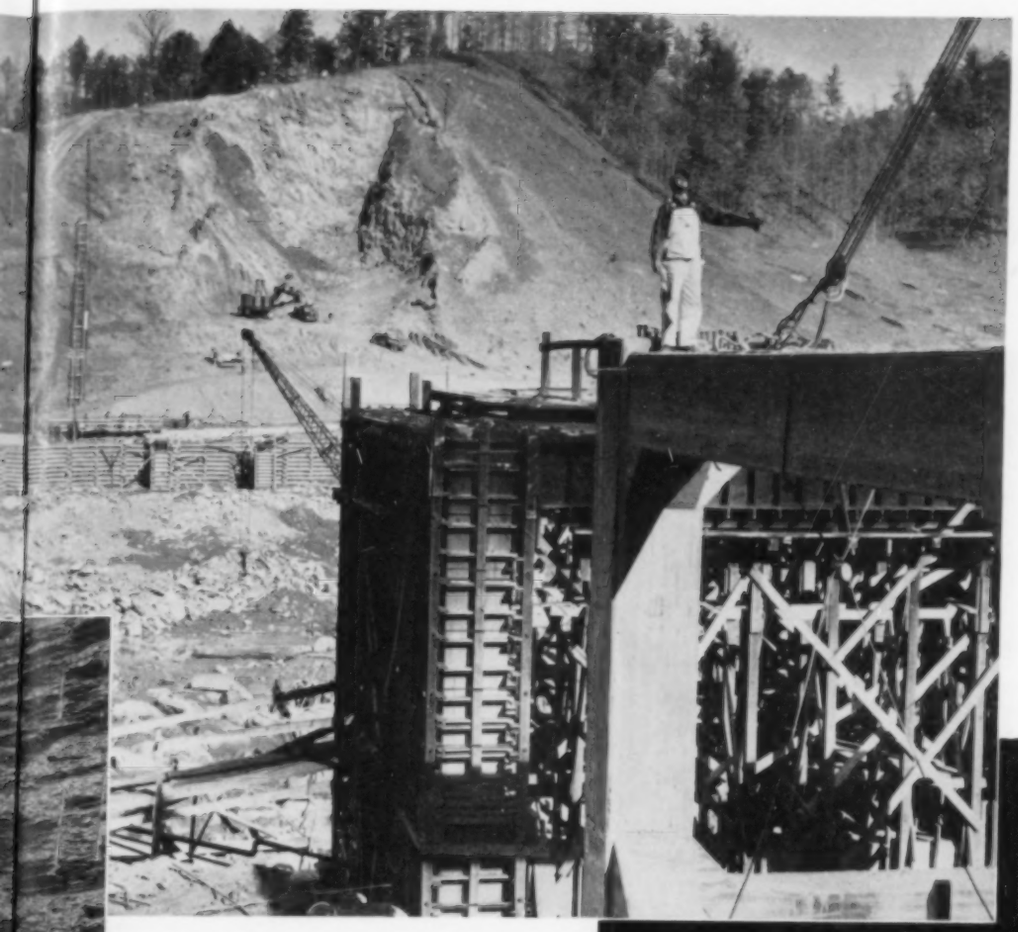
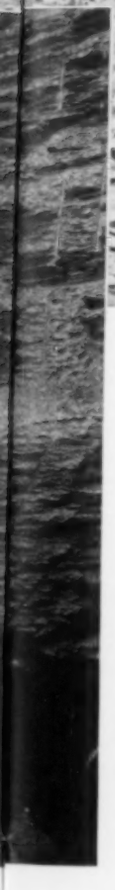
The Apalachia Project of the TVA

C. H. Vivian

AMONG the extensive current construction activities of the Tennessee Valley Authority, the Apalachia Project merits special attention because it includes a greater variety of hydraulic features than any previous TVA undertaking. A $20,000,000 job, it will consist of a concrete dam 150 feet high from which water will flow through more than 8 miles of conduit and then drop through two penstocks to the turbogenerators. The structure will be located on the Hiwassee River, 66 miles upstream from the point where it enters the Tennessee and approximately 10 miles downstream from Hiwassee Dam, which was started in July, 1936, and began generating power in May, 1940. Well along towards completion upstream from Hiwassee are Chatuge and Nottely dams. After passing through the turbines in the Apalachia power plant, the water will be returned to the Hiwassee River. The Apalachia dam site is in Cherokee County, North Carolina, while virtually all of the conduit and the powerhouse will be in Polk County, Tennessee. The project is a part of the second emergency program of the TVA, and is being rushed to completion to make available as soon as possible the block of power that it will contribute to the TVA system. A force of 3,000 men is now at work on the job.

Apalachia Dam will create a lake extending 10 miles up the river to Hiwassee Dam. As the canyon throughout that stretch is comparatively narrow and steep-sided, the reservoir, at normal full-pool level, will have a surface area of only 1,150 acres. Its total storage capacity will be but 62,500 acre-feet. This is too small a volume to have a noticeable effect on flood control of or navigation on the Tennessee River, and the project is consequently planned solely for the production of electricity. The amount of water available for passage through the turbines will, of course, be determined primarily by the discharge from Hiwassee Dam upstream. Long-term records indicate that the average annual precipitation throughout the 1,000-square-mile watershed above Hiwassee Dam is approximately 57.5 inches. The recorded flow of the river at Reliance, which is a few miles downstream from the Apalachia power-plant location, has ranged from a minimum of 134 second-feet during September, 1925, to a maximum of 56,000 second-feet on April 2, 1920. The average natural flow for a 12-year period at Apalachia, just downstream from the dam site, was 2,120 second-feet. Studies of these and other hydrological data indicate that the storage capacity of Hiwassee, Chatuge, and Nottely reser-





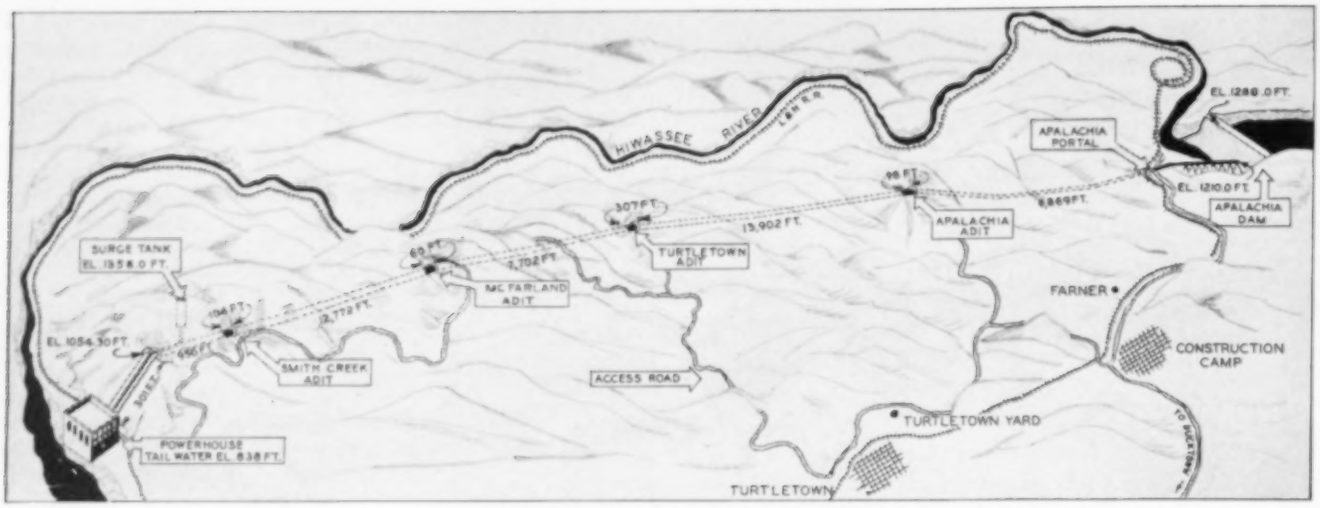
ALL AROUND THE JOB

Above is a view from the south bank of the Hiwassee at the dam site, showing the opposite abutment. The river is beyond the cribwork of the cofferdam wall. The picture at the right was taken from the portal of one tunnel section at Smith Creek Adit looking across at the portal of the next section. In the foreground are Roy Kees, left, assistant tunnel superintendent, and R. K. Jones, tunnel foreman. At the left is the downstream end of the tunnel, with the two openings to which the penstocks will be connected. In the space in the foreground, from which 4,000 yards of material was excavated, will be erected a valve house for controlling the water going to the turbines. At the upper left is the powerhouse site as viewed from the point from which the penstocks will drop.

voirs can be utilized to insure the Apalachia Project a minimum supply of 2,120 second-feet during an abnormally dry year like 1925, and an average of about 3,000 second-feet during a normal dry season. It is therefore expected that the turbines will be operated well-nigh continually during the dry season and may be run for peaking purposes during the filling period of the upstream storage reservoirs.

From Hiwassee Dam to the Apalachia Project powerhouse location the river flows approximately 22.3 miles and falls 434 feet. Under ordinary conditions there would be erected at the power-plant site a dam high enough to back the water up to the tail-water elevation of the Hiwassee hydroelectric station. However, if this plan were carried out, the tracks of the Louisville & Nashville Railroad, which follow the stream for a distance of about 11.5 miles upstream from the powerhouse site, would have to be relocated. Because this would entail great expense without commensurate benefits, the alternate scheme was adopted—that of constructing a comparatively low dam just upstream from the place where the railroad leaves the canyon and of diverting the river through a conduit extending from the dam to a point in the canyon above the power-plant location downstream.

The dam will have a deck elevation of 1,288 feet, and the normal full-pool elevation of the reservoir will be 1,280 feet. The invert of the conduit intake will be at Elevation 1,212, and the water will flow through the channel on an average gradient of 0.0362 per cent, dropping 157.7 feet between the dam and the entrance to the



GENERAL LAYOUT SKETCH

Because of the railroad line that follows the river, it was not economically feasible to build a high dam at the lower end of the project and inundate the canyon. Instead, the alternate scheme shown here is being developed. Apalachia Dam will back the water up 10 miles to Hiwassee Dam. The dotted line indicates the course of the 42,201-foot tunnel, and the arrows point to the various working sites from which it is being driven. The possibility of substituting either a pipe line or a flume for the tunnel was studied, but these were found to be much less desirable and more costly than a tunnel. At a later date there may be erected at Austral, a few miles downstream, another dam that will back the water up to the Apalachia power plant and raise its tail-water elevation by as much as 44 feet. For that reason the lower walls of the powerhouse are being made watertight.

penstocks, which will be at Elevation 1,054.3. As the minimum tail-water elevation at the powerhouse will be 838 feet, the maximum head of the penstocks will be 216.3 feet. The combined maximum static head of 442 feet which the system will provide will be reduced under normal operating conditions to approximately 400 feet after friction losses are deducted. At some future time another dam may be built 8.5 miles downstream from the Apalachia power station at Austral where the river leaves the canyon. If this is done, the tail-water elevation at the Apalachia power plant will occasionally be raised as much as 44 feet, and the effective head of the Apalachia system will consequently be reduced.

IN CHARGE OF WORK

At the left is T. L. Brown, construction superintendent for the Apalachia Project. With him is George Foster, tunnel superintendent.

The conduit, exclusive of the penstocks, will have a length of 43,676.5 feet. Of this total 42,201 feet will be tunnel and 1,475.5 feet will be steel pipe. The longest single section of pipe will extend 906.5 feet from the dam to the upstream portal of the tunnel system. The tunnel alignment and grade were laid out so that the line runs close to the surface at four points where erosion has created low spots in the mountain range, thereby providing access for additional working places. As a result, the tunnel is divided into five sections, with ten available headings. Starting at the upstream end, the sections are 6,869, 13,902, 7,702, 12,772, and 956 feet long, respectively. The last of these, which is at the powerhouse end of the line, has already been holed through, leaving eight possible working headings at seven of which operations are in progress. By dividing the line in this manner tunneling is being greatly speeded up, and it is expected that the final section will be holed through next September. Save for about 300 feet at the power-plant end where it will branch out into two smaller bores leading to the penstocks, the tunnel will have a circular cross section of 20 feet. It will be lined with concrete 1 foot thick, reducing the inside diameter to 18 feet.

The Apalachia Project was authorized on July 16, 1941, and work was started the same day on the building of a camp and access roads. The dam site is about 14 miles north of Ducktown, Tenn., with which it is connected by a state highway that crosses the river a short distance downstream from it. The nearest town is Farner, Tenn., and as it is a railroad point it was made the receiving end for equipment, with the general offices and camp close by. Roads had to be run from the camp to the dam and powerhouse sites and to four intervening places from which tunneling was to be carried on. Although it was possible to widen and to improve some of the existing roads, 13 of the total 21 miles is new construction. As the country is very mountainous, circuitous routes had to be followed, as indicated on the accompanying general location map. Although the water flowing through the completed hydraulic system will travel only about 8.5 miles from the dam to the power plant, the distance between the same points by way of the road system is 18.1 miles.

Before actual tunneling could be started at three of the four intermediate working places—Apalachia, McFarland, and Smith Creek—open-cut adits had to be excavated to gain access to the tunnel line. They are on the same level as the tunnel invert and at right angles to the tunnel line. These open sections—102 feet at Apalachia, 60 feet at McFarland, and 104 feet at Smith Creek—will be spanned by steel pipe which will be encased in concrete and backfilled. At the Turtletown Adit the tunnel line crosses Turtletown Creek at an elevation 30 feet higher than that of the stream and of the headings opened 307 feet apart on opposite sides of the valley. The connecting steel pipe for this section will be carried on supporting steelwork. Tunneling operations got underway first at McFarland Adit on

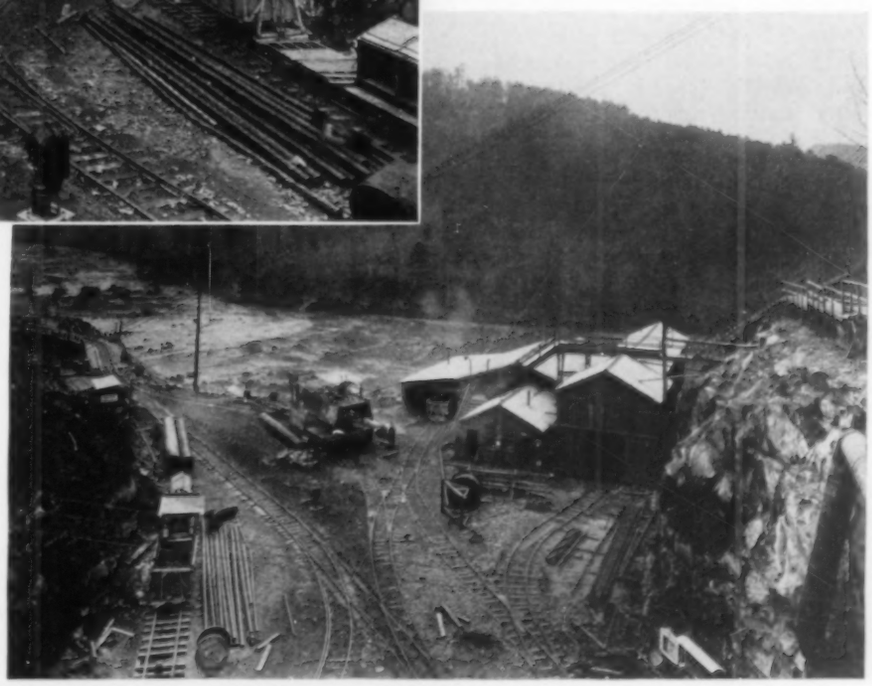
October 13, and Turtletown Adit was the last to get started, one heading being opened on December 25 and the second one on January 11 of this year.

Although the TVA has been building dams and other hydraulic structures since 1933, the Apalachia Project represents its first venture in tunnel-driving. For that reason particular attention was paid to that phase of the undertaking and its supervision was placed in the hands of trained men. Several among the directing personnel date their underground experience as far back as the Moffat Tunnel that was driven in Colorado in the middle 1920's, and collectively they have worked in practically every hard-rock bore of importance that has been put through since that time. Despite that fact, the job is conspicuous for the youthfulness of those in charge, the average age being well under 40. Among the tunnel laborers also are many seasoned veterans.

The beginning of the Apalachia Project fortunately coincided with the completion of some of the sections of the Delaware Aqueduct in New York State, and many of the "tunnel stiffs" thus made jobless drifted southward, attracted by the promise of a mild winter climate and a few months' work at good pay. The wages, incidentally, are higher than those paid on the Delaware Aqueduct. Tunnelers, however, are confirmed wanderers, and many of them remain only long enough to accumulate a stake and then move on. Consequently, the labor turnover is high, but experienced men are continually arriving to take the places of those that leave. As a result there is no lack of efficient crews, and the progress being made not only exceeds the marks the TVA engineers have set for themselves but compares favorably with the best performances registered in recent notable hard-rock operations conducted elsewhere in the country. The daily footage at the seven headings has been averaging around 30, and has been as high as 53 at a single heading. When it is considered that approximately 14 cubic yards of rock is excavated for each linear foot of advance, the total muck removed per day is in the same range as that handled in the case of some of the recently completed smaller bores where records were set.

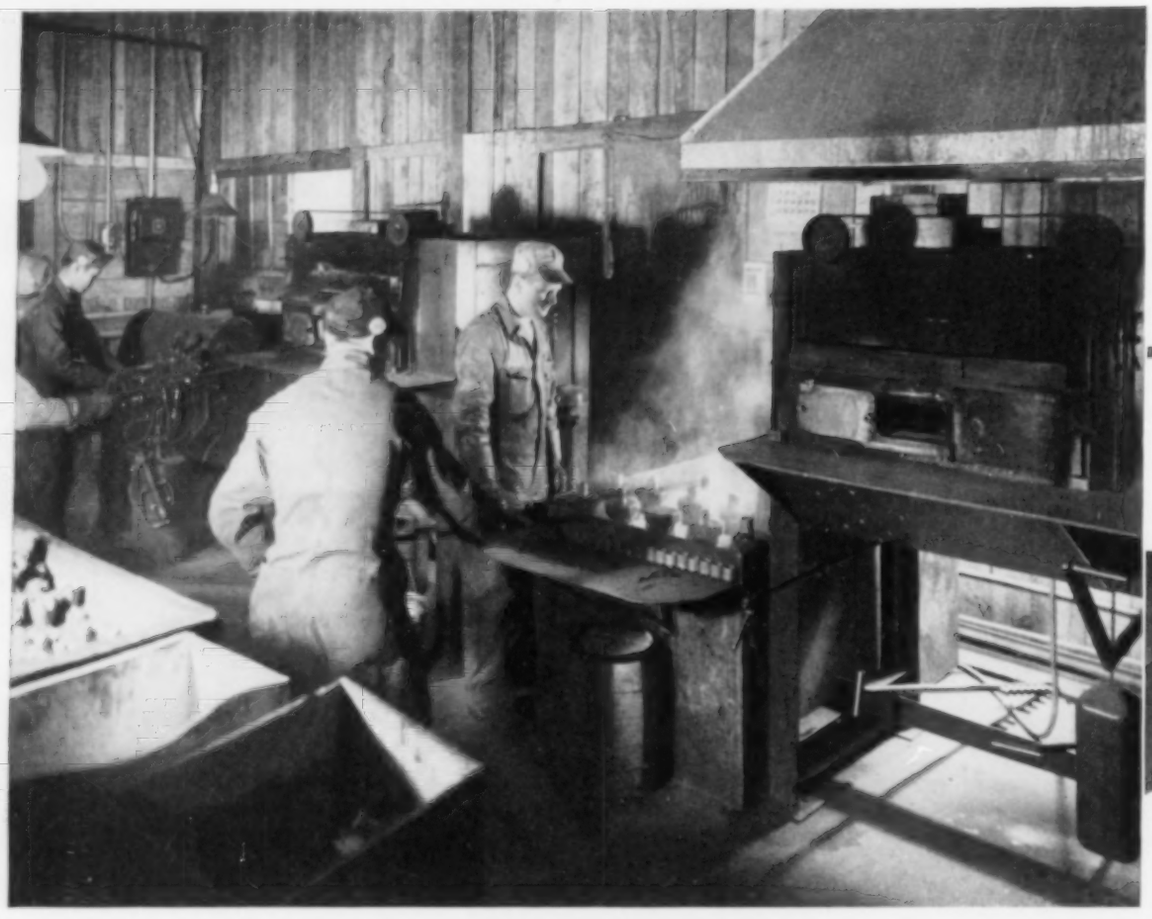
The tunnel is being driven through a series of metamorphic rocks; that is, sedimentary rocks that have been altered by pressure, bending, and other forces exerted during mountain-making movements of the earth's crust. The geologists describe the area as a gradational zone between extreme metamorphosed and sedimentary rocks. There is considerable variation in the 8 miles, and three distinct formations will be cut through. At the upstream end are mica schist and alternate layers of slate and quartzite, with the latter greatly predominating. Then comes 1,000 feet of hard conglomerate quartzite. From that point to the downstream end is principally slate. Except for the quartzite, the material is not classed as hard to drill. The dip of the strata varies widely, but it is generally steeper at the upper end. In the vicinity of Smith Creek the layers are nearly horizontal. Throughout the formations penetrated have been encountered bedding and fault planes filled with quartz which appears in streaks up to several inches wide and runs across the faces of the headings. From a drilling standpoint, the principal difficulty lies in the frequent changes in the hardness of the rock. Comparatively little water is struck in the workings, and the walls and roofs are generally stable enough to stand without support.

Operations and equipment at all headings are largely standardized. Full-face drilling is done from carriages that were designed and built by TVA forces. Each has a framework of either pipe or structural steel and is 29½ feet long and 17½ feet high. There are two decks, which are



APALACHIA ADIT

On either side in the picture above are the tunnel portals, the gap between them being 98 feet. The large pipes entering the bores are ventilating lines from the blower plant. The building at the top is a change room that contains lockers and shower baths. The other picture is a view from the hillside looking down on the Hiwassee River. A drill carriage with its wings down stands on the track just short of the river. In the left foreground is a car used by workmen for scaling down the roof of the tunnel on Sundays, and at the right are the blacksmith and repair shops.



RECONDITIONING BITS AND DRILL RODS

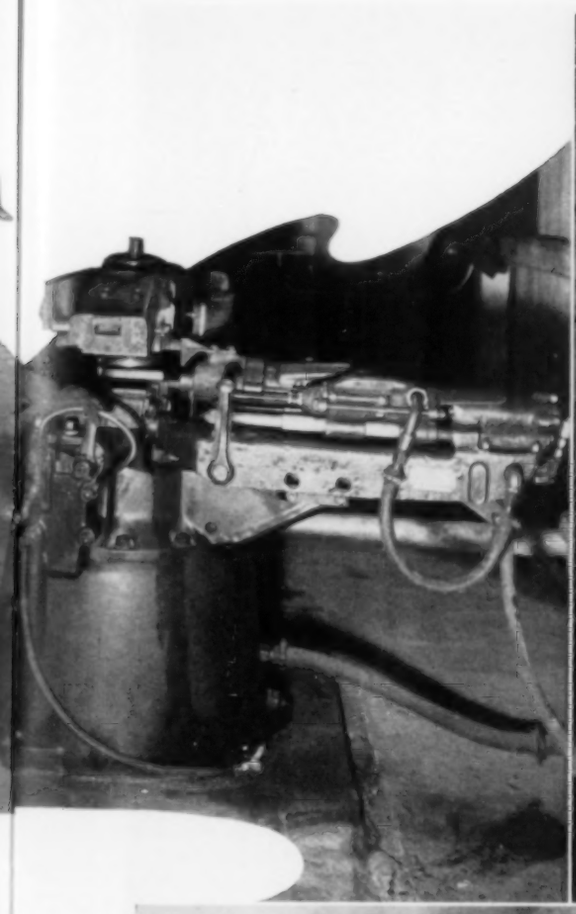
The picture above shows the Jackbit crew in one of the three blacksmith shops along the tunnel line. In the background is a Jackmill and the pyrometer-controlled Jackfurnace that serves it. The man in the middle is quenching bits heated in the Jackfurnace at the right. Jackrod shanks are being forged in the I-R 54 sharpener in the center. The pyrotechnic display at the upper right is caused by the grinding of the end of a shank on a No. 500 air-operated grinder. Jackbits of the various sizes required are taken into the tunnels in boxes kept on the jumbo. Rods are hauled by steel cars, such as the one shown at the lower right, which are stationed behind the drill carriage.

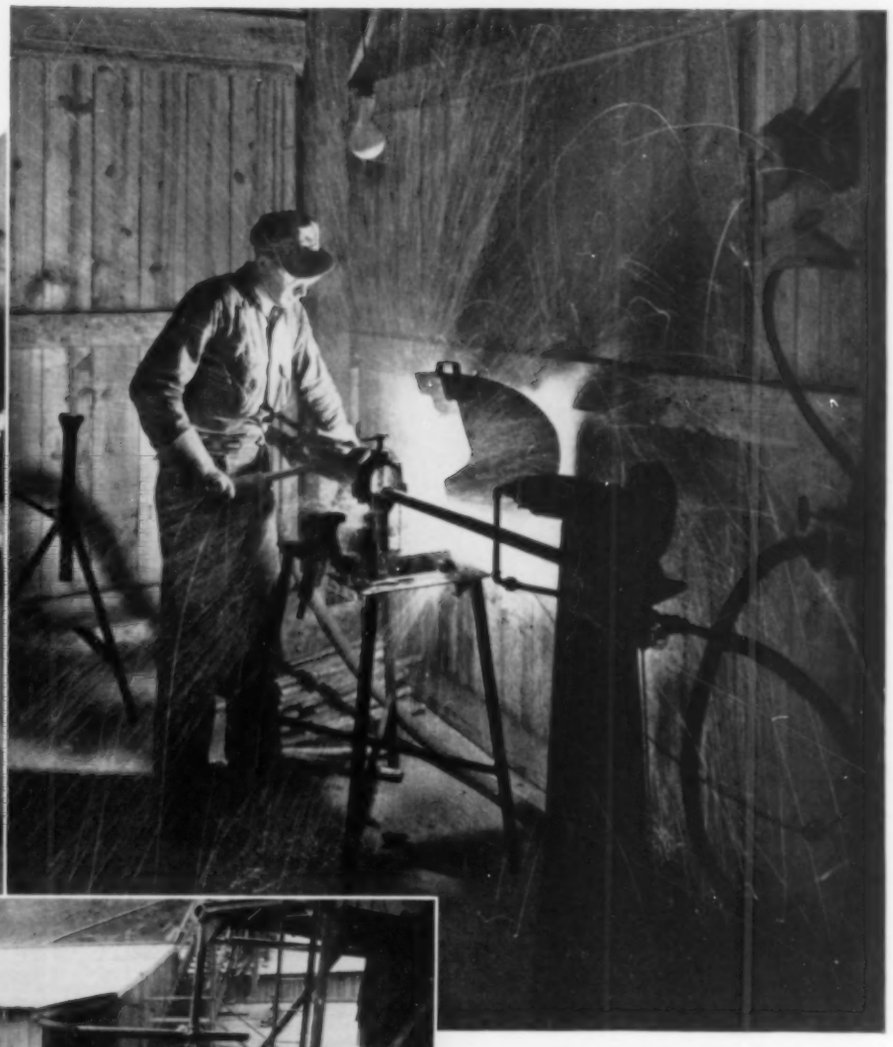
5 feet 5½ inches and 12 feet 3 inches above the rails, respectively. On each side of the platform are hinged steel-plate wings which are raised to the horizontal position when the carriage is made ready for drilling. By lowering them and swinging around the column arms on which the drills are mounted the over-all width of the carriage can be reduced to approximately 6 feet, giving muck trains plenty of room to pass when it is parked on a siding a few hundred feet back from a heading.

All the drills are Ingersoll-Rand DA-35 drifters equipped with power feed. Each carriage ordinarily carries eleven: three at the bottom, four at the center, and four at the top. At some headings a fifth machine has at times been mounted at the top. From 65 to 70 holes constitute a round. Cut holes are 13 feet deep and all others 11 feet. All drilling is done with Ingersoll-Rand Jackbits on 1¼-inch Jackrods having respective lengths of 3, 5, 7, 9, 11, and 13 feet. At the outset, holes were started with bits 2¼ inches in diameter, but in the interest of greater drilling speed 2-inch starter bits were substituted. At the same time, the bit size with each change was reduced from ⅛ inch to 1/16 inch. This has resulted in bottoming an 11-foot hole at a diameter of 1¾ inches, as formerly, while 13-foot holes are finished at $1^{11}/_{16}$ inches, as against 1⅝. Blasting is done with 40 per cent Atlas gelatine dynamite in 1½x8-inch sticks. Holes are loaded from the drill carriage and are detonated electrically either by means of a switch at the portal of the tunnel or by a transformer inside. The powder consumption ranges from 4½ to 5½ pounds per cubic yard of rock broken.

Muck is loaded with Conway mechanical loaders into 5- and 6-ton steel side-dump cars. These, and the Goodman 8-ton storage-battery locomotives used for haulage, were obtained from the Delaware Aqueduct to enable the work to get underway without delay. The trains and the drill carriages run on 3-foot-gauge track of 60-pound rails in 30-foot lengths. As a muck pile recedes toward the working face, temporary rails made up of 6-foot sections are laid by the heading crew so that the mucking machine can keep advancing. After ten of these sections have been laid, the rearward five are replaced with a regular 30-foot rail by the track gang. Switching of empty cars to the head of the muck train as loading progresses is done by a manually operated device, which is described in connection with an accompanying illustration.

Approximately 45 cars in trains of five each are loaded after a blast. At the Apalachia, Turtletown, and McFarland adits, from each of which two headings are being advanced, a locomotive takes a load of muck all the way out to a dump and returns to the working face—two engines doing the hauling from each heading. At Smith Creek, with only one heading, a single locomotive pulls the loaded train several hundred feet back from the face to a siding. By the time it reaches that point a train of empties has returned and is waiting on the main track. The two motormen trade trains, the empties going to the heading and the full cars to the dump. Under this system the haul is divided between the two men and the same motorman handles the train at the heading throughout a shift. During the mucking period the members of the drilling crew are allotted various tasks. Some of them

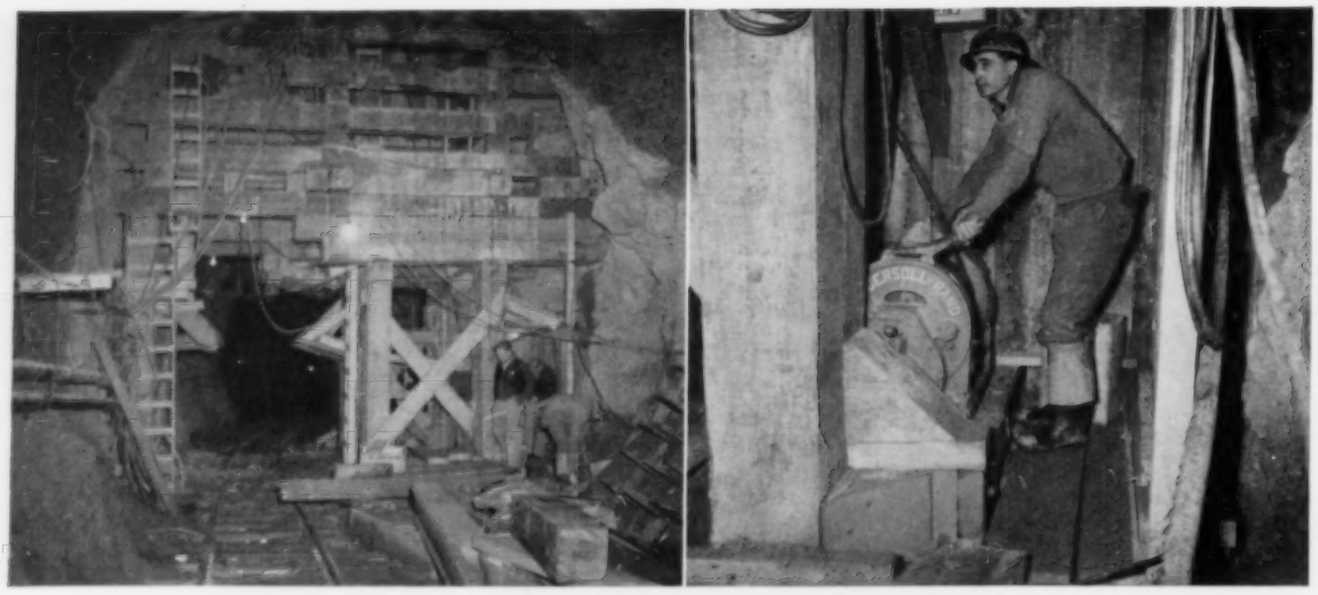




help around the mucking machine and lay the 6-foot temporary rails as they are needed. Two men clean and service the drill carriage. Others shift empties in the tunnel or assist in dumping the muck cars outside.

Fresh air is conveyed to within 100 feet of each heading through 30-inch spiral-weld piping extending from blower plants outside. This equipment previously served some of the Delaware Aqueduct sections. The air supply in each case approximates 20,000 cfm., which is double the volume considered necessary to insure a good working atmosphere. The air is blown into the tunnel sections at all times except immediately after blasting, when it is exhausted for a period of 15 to 20 minutes to withdraw smoke and powder fumes.

In order to get the Apalachia Project started as soon as possible, 34 portable compressors were employed during the first few weeks. As fast as they could be procured and assembled, thirteen stationary machines were set up at five points along the tunnel line. The plant at Apalachia Portal was designed to serve both the nearby dam area and the heading. After that tunnel section had been driven for a distance of 1,230 feet operations were discontinued because of a shortage of haulage locomotives and mucking machines, and it will probably be completed by working from the opposite heading at Apalachia Adit. At the latter and at Turtletown, two of the portables initially used—both Ingersoll-Rand 500-cfm. models powered by oil engines—now augment the supply from the stationary compressors. From the plant at Smith Creek Adit a line has been run to the powerhouse site to furnish air for drilling. The units serving the tunnel sections discharge at from 105 to 110 pounds pressure, and the air reaches the drills at around 100 pounds, save when there is an inordinate drain on the lines. At locations where one plant provides air for two headings an effort is made to stagger the operations so that both drill carriages will not draw air at the same time. The air is conveyed into the tunnels through 6-inch spiral-weld piping. Four-inch "bull hose" is used to make



RAISE FOR SURGE CHAMBER

At a point about 400 feet from the lower end of the tunnel, a surge chamber will rise 300 feet vertically through the rock to the top of the hill. A pilot raise is being driven from the tunnel and will be enlarged by excavating from the surface. The muck will be drawn into cars in the tunnel from a chute equipped with pneumatic gates. The view at the right shows an air-operated hoist used to handle equipment and materials during the work in the pilot raise.

connection with each drill carriage, which is equipped with a 6-inch manifold having take-offs for the several drills.

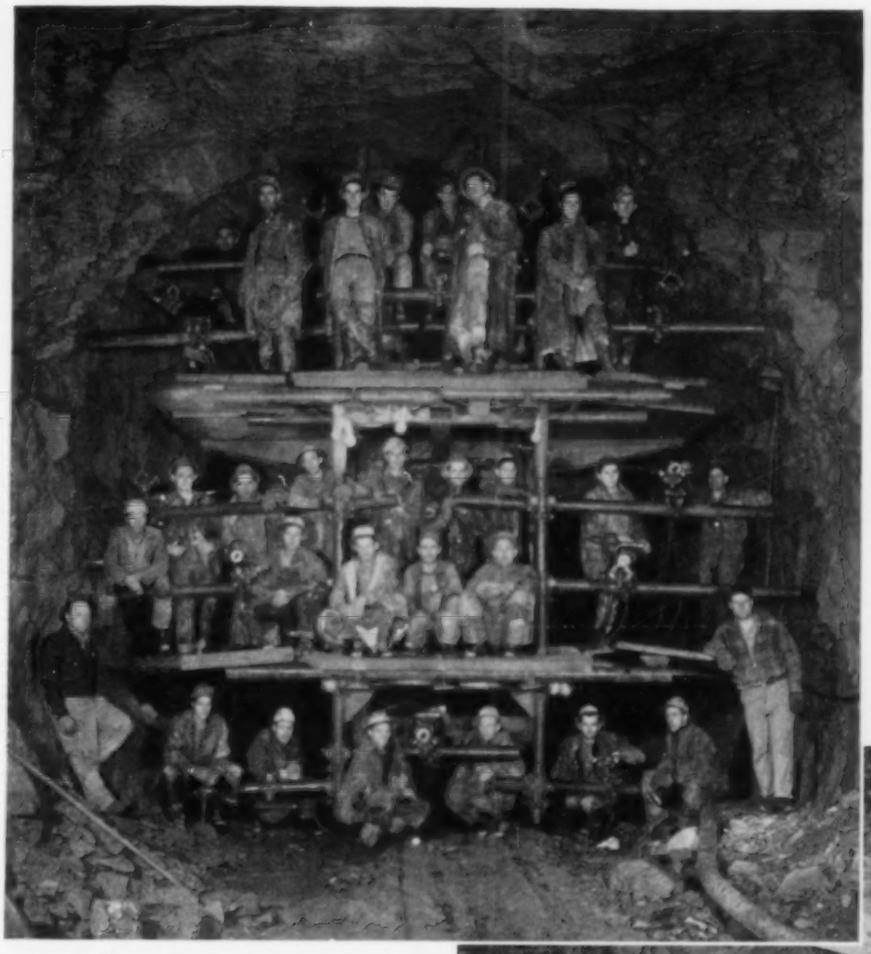
As the general layout sketch shows, a surge chamber, approximately 300 feet high, will rise from the tunnel line and at a point about 400 feet from the downstream end of the conduit. Taking advantage of the topography, it is being made in the form of a circular, vertical opening extending to the crest of the hill through which that section of the tunnel runs. When lined with concrete, the lower 80 feet of the chamber will have a diameter of 18 feet; above that level it will be 66 feet in diameter. It is being excavated by driving a 7x14-foot pilot raise with stopers from the roof of the tunnel to the top of the hill, the muck being drawn down through a chute and hauled to the dump at Smith Creek Adit. This raise will be enlarged to full section by working from the top downward. Vertical holes will be drilled with Jackhamers, and the blasted material moved to the centrally disposed chute by means of a tractor-mounted bulldozer. The rock floor will be divided into four sections so that drilling can be going on in one while mucking is in progress in others. The chute will be kept filled to the excavation level by controlling the rate at which the material is withdrawn from the bottom. A derrick on top of the hill will hoist the tractor and other equipment out of the excavation prior to blasting.

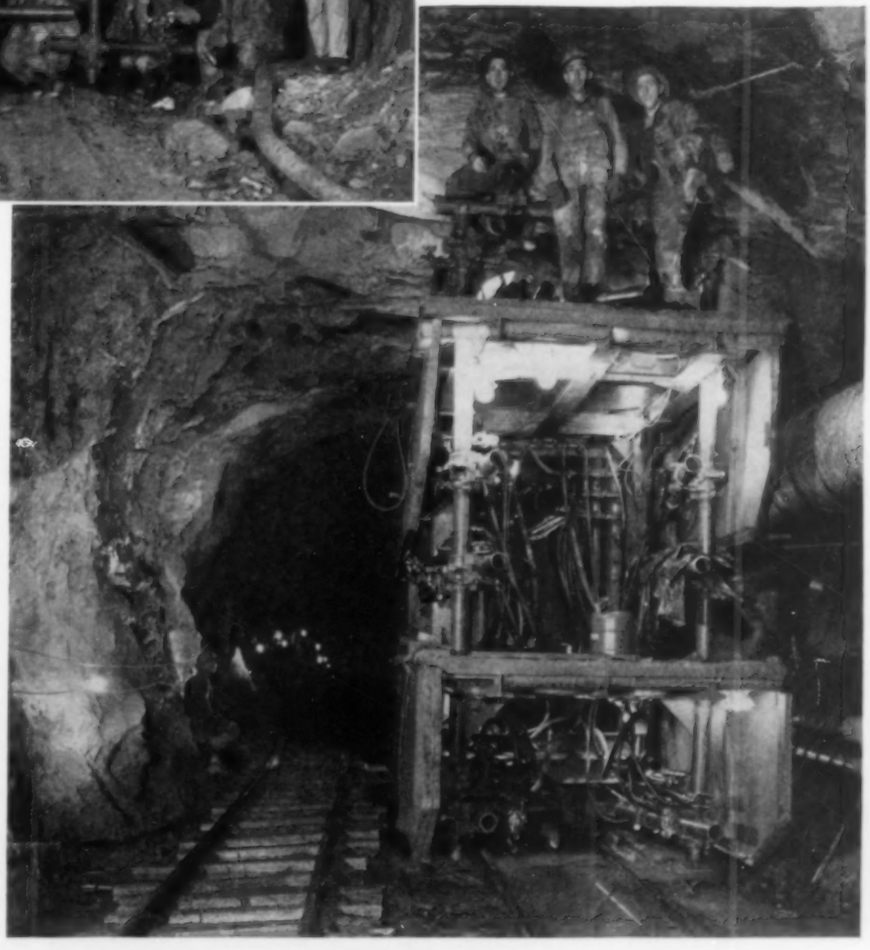
For handling the Jackbits and Jackrods, blacksmith shops are maintained at Apalachia, McFarland, and Smith Creek adits. The equipment at each of the two first-mentioned locations includes: One I-R Jackmill, two I-R Jackfurnaces, one 4P pedestal grinder, one No. 500 cut-off wheel, one No. 54 drill-steel sharpener, one 10-fixture bit-quenching tank with a water-circulating pump, and one Toledo power threader for Jackrods. The Smith Creek shop is similarly outfitted, except that it has no power threader. The Apalachia shop not only serves the two tunnel headings at that point but also reconditions the bits and the wagon-drill and Jackhamer steel in use at the dam excavation, as well as the bits required in drilling the foundation for Ocoee No. 3 Dam, which is being built by TVA forces on the Ocoee River about 20 miles from the Apalachia job. The McFarland shop takes care of all bits and rods in service at the two headings there and at the two Turletown headings. In addition, it threads the rods needed at Smith Creek and at the powerhouse excavation. Except for the latter work, the Smith Creek shop reconditions all the bits and steel in use at the tunnel heading, the surge-tank raise, and the power-plant foundation. The number of bits handled in each of these shops differs considerably from day to day because they are not brought in from the working places served until a sizable supply has accumulated. Variations in the rock formation also affect the number of bits coming from the tunnel headings. In soft rock, a bit is often used two or three times before it requires milling.

The Apalachia Dam will be of the concrete gravity type and will be 1,319 feet long at the crest. At the two ends will be nonoverflow sections having respective lengths of 655 and 290 feet, with a 374-foot spillway between them. The latter will consist of ten 23x32-foot taintor gates which will provide for the passage of 156,000 second-feet of water, representing, it has been computed, the greatest possible flood in this stretch of the Hiwassee River. The intake for the conduit will be near the left abutment of the dam (looking downstream) and will be equipped with a trashrack, gate, and hoist mechanism. The dam will contain approximately 215,000 cubic yards of concrete. This will be poured from 4-yard buckets handled by whirler cranes operating on a steel trestle that will span the river just downstream from the dam line. The trestle will be removed after concrete-placing is completed.

Excavating for the dam foundation is proceeding rapidly, the Hiwassee having been diverted to the left side of the valley by means of a rock-filled timber cofferdam within which a large area of the river bed has been exposed and made accessible for work. From 12 to 30 feet of overburden covered the rock throughout a large part of the dam site. The rock is generally sound and the geological conditions are favorable, the strata dipping slightly upstream and striking across the valley at almost right angles to the direction of the flow.

A concrete mixing plant with three 2-yard Smith tilting mixers is being erected on the left abutment and just downstream from the dam. Aggregates will be shipped in by railroad and will be unloaded at a point about half a mile from the building site and some 400 feet higher in elevation. A conveyor system will transport them to nearby stock piles, from which the classified material will be conveyed to the mixing plant by a series of connected flights of 30-inch conveyor belts. Cement will be delivered from the unloading station by





a pipe line, using the Robinson pneumatic system.

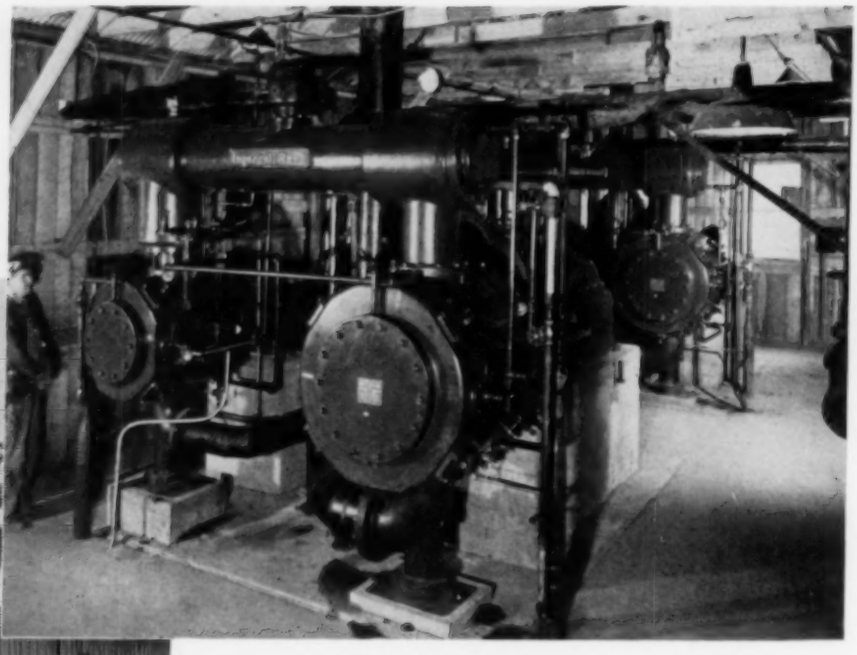
The upstream half of the tunnel will be lined with concrete from the mixing plant at the dam. Another plant, consisting of three 1-yard Construction Machinery Company mixers, will be set up at the McFarland Adit. Cement and aggregates will be received at a nearby railroad siding. The former will be blown to the mixing plant by the Robinson system and the latter will be transported by a belt-conveyor system. The McFarland plant will mix concrete for the downstream half of the tunnel up to the point where it divides into the two smaller branches leading to the penstocks. These twin bores will receive concrete from portable mixers. From the plants at the dam and the McFarland Adit, concrete will be hauled into the tunnel in 5-yard agitator cars drawn by diesel locomotives and will be placed in Blaw-Knox forms. The invert will be poured and screeded, while the arch and roof sections will be shot into place by Press-weld guns with compressed air. It is estimated that from 175,000 to 200,000 cubic yards of concrete will be required for the lining.

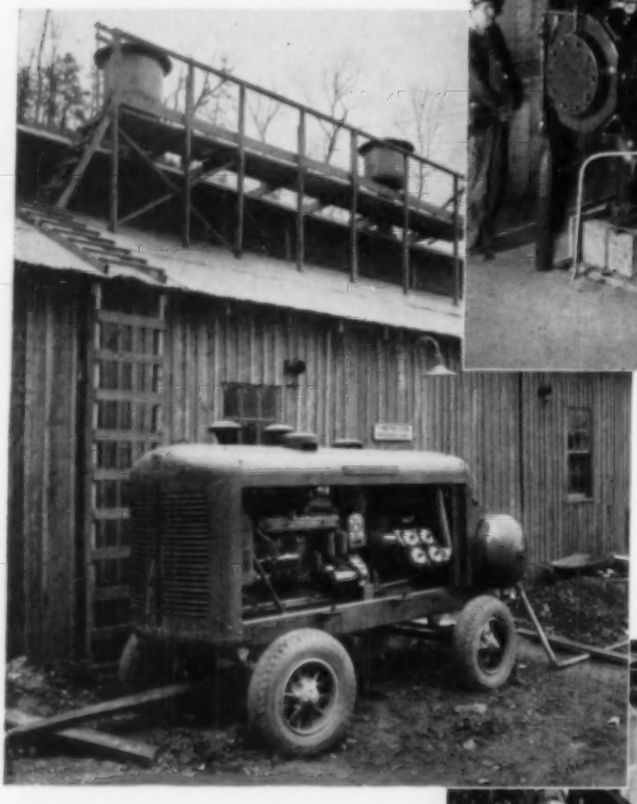
The powerhouse foundation is being excavated within a cofferdam at the river's edge, the necessary drilling being done with Jackhamers and wagon drills. The lower part of the walls will be of watertight construction to protect the equipment in case the subsequent erection of the Austral Dam raises the tail-water elevation. Two Francis turbines, rated at 53,000 hp. when operating at full gate under a net head of 360 feet, will each drive a 37,500-kw. generator. The turbines will run at 225 rpm., and each will discharge 1,500 second-feet of water at maximum capacity. When operating at highest efficiency under a net head of 380 to 400 feet the discharge will be between 1,050 and 1,300 second-feet. Materials and equipment for the power plant are being delivered directly to the site by railroad, which will be relocated there to provide more room for the powerhouse and will be elevated and run between the latter and the river.

The narrowness and steepness of the access roads, the use of some of them by logging contractors, and the absence of parking space at several of the working places have created a transportation problem that the TVA has met by providing bus service for several hundred of its

DRILL CARRIAGE

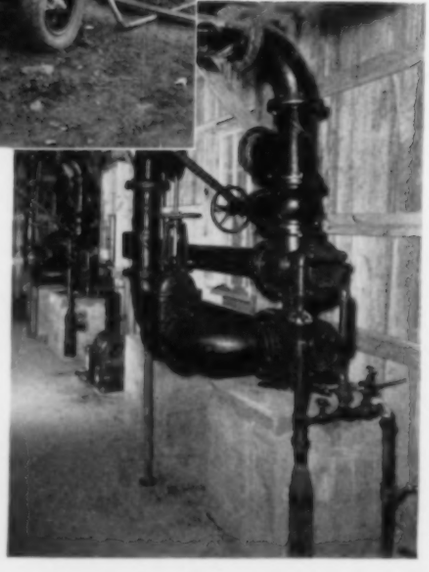
At the top is a drill carriage with its crew, ready to start drilling at the east Smith Creek Adit heading. The other picture shows the same carriage on a siding during mucking operations. With the platform wings down and the drill-column arms swung back, there is ample room for the passage of muck trains on the main track.





COMPRESSOR PLANT

In the five compressor plants along the tunnel line there are seven Ingersoll-Rand Type XRE synchronous-motor-driven units such as those shown above. They are at the Apalachia Adit and discharge into aftercoolers (below) which extract moisture from the air before it enters the distribution system. Outside that compressor house (left) is a 500-cfm. oil-engine-driven Mobil-Air portable that supplements the output of the stationary machines.



workmen. Except for the use of small "pickups" by engineers and those in supervisory capacities, all employees travel to and from Turtletown, McFarland, and Smith Creek adits and the powerhouse in these large vehicles. A bus terminal has been established at Turtletown Yard, 3½ miles from the construction camp. Workmen drive their own cars to that point and then board the buses. Eight, each with seats for 40 persons, are in service most of the 24 hours of every day but Sunday. By staggering the hours of changing shifts, this number suffices to meet the demand.

About 80 men are employed on every shift at each of the tunnel adits, and there is a larger force at the power plant. Owing to time spent in riding to and fro, the workers at the power station and at Smith Creek adit are given an extra hour's pay each shift, and those at McFarland and Turtletown adits receive compensation for an additional half-hour. Twenty-one drivers, all experienced, are available, which provides an extra for each shift. Although buses frequently carry as many as 50 men each, careful driving has kept the accident record clean. Police officers of the TVA, who are on duty continually, keep unauthorized persons off the roads, and admission to the work is by pass only. Adequate parking space exists at the dam and at Apalachia Adit, and employees at those places are permitted to drive their own automobiles.

In line with its long-established policy, the TVA maintains a department at Apalachia to safeguard the health and safety of all project workers. Applicants are given a physical examination, including X-raying of the lungs. Those who are found fit are classified into three groups, A, B, and C. From a man's rating the personnel department knows to what kind of employment he can be safely assigned, and these records are consulted when filling requests from the construction department for additional help. For example, if a man's lungs are not normal, he will not be given work that might aggravate his condition. Those with defective vision are put on jobs that keep them on the ground. Class C men have to be passed by a safety engineer before they can go to work.

The rock in the tunnel sections ranges as high as 27 per cent in silicon dioxide, and special measures are taken to guard against dust. Dust counts are taken at regular periods, and sufficient air is blown into the workings to hold the dust concentration down to 50 per cent of that considered safe for breathing. Gas tests also are regularly made, and temperatures and fogging tendencies of the atmosphere are noted. A representative of the U.S. Public Health Service is a laboratory assistant, and Theodore Hatch, well-known industrial hygienist, serves as a consultant.

A safety engineer is on duty in each tunnel section on all shifts, and two are stationed at the dam. All employees are issued hard hats. Tunnel portals are gunited to prevent loose rock from falling, and gunite is also applied to the roofs in areas where there are any indications of weakness or signs of spalling. A wait of a certain period after blasting is enforced

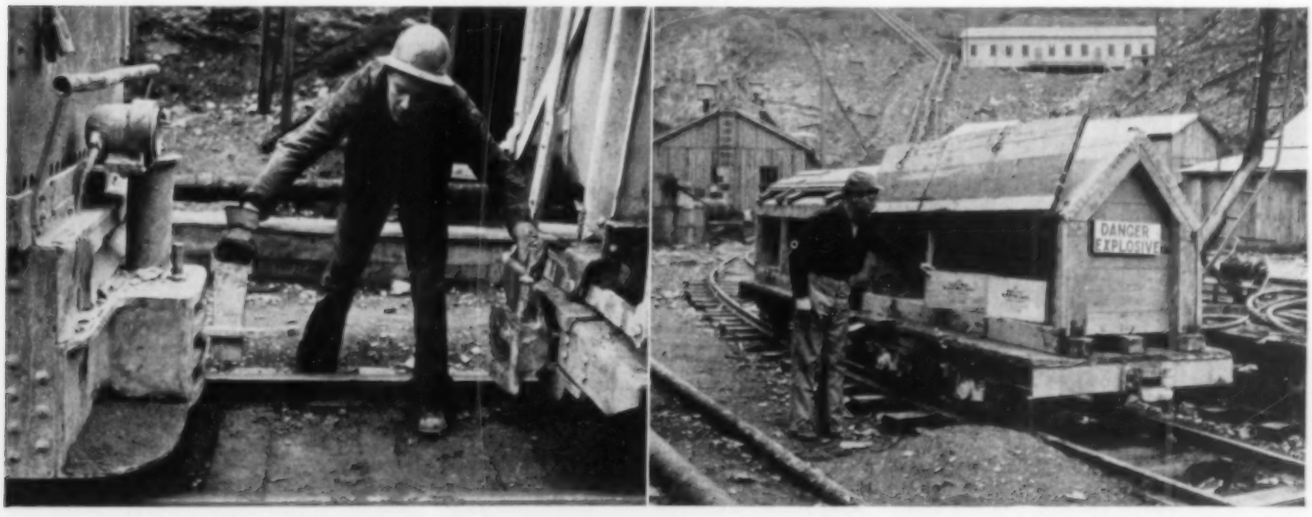
before men are allowed to return to the working faces. Except on certain authorized trips when they are taken to the headings in cars, men are not permitted to ride muck trains. Car couplings have special holders welded on to them to make for safer handling, and automatic couplings have been ordered for one tunnel section for the purpose of trying them out. A traffic director is stationed just outside of each tunnel portal at all times to guard against possible train collisions.

Each tunnel adit has an isolated, fenced powder magazine which is floodlighted at night and surrounded by a firebreak—an area from which all trees and vegetation have been removed. Small supplies of explosives are obtained from these magazines for use at the adits, and at each of the latter is a magazine similarly protected by a firebreak. Explosives are taken into the tunnel in a special car having a wood body with two compartments, one for powder and the other for primers. An experienced powderman is in charge of the loading of all holes. These workers are interviewed by the safety engineer before they are hired and are given an intelligence test in addition to the usual physical examination. The staff includes a man authorized by the U.S. Bureau of Mines to teach first aid and mine-rescue work, and the teams he trains are awarded bureau certificates. He recently concluded a 30-hour course for blasters and all men handling powder. Each tunnel foreman is required to hold a safety meeting of heading crews once a week, and for the psychological effect he usually conducts it immediately after a blast has been fired. Meetings are also held periodically for all employees at each adit, with someone in a supervisory capacity serving as speaker. First-aid dressing stations are at all adits, and an ambulance is stationed at each one. Telephone communication is maintained at all times with a hospital at the construction camp where doctors and nurses are on duty at all hours seven days a week. All of these activities are under the supervision of J.N. Hardy, district safety engineer for the Health and Safety Department. Dr. O. M. Derryberry is administrator.

The work described is being done by TVA forces under the general direction of T. B. Parker, chief engineer, and A. L. Pauls, chief construction engineer. The undertaking is classed as a Division of the Hiwassee Projects, of which George K. Leonard is project manager and C. P. Wright is construction engineer. Thomas L. Brown is construction superintendent in direct charge of the Apalachia work. George Foster is tunnel superintendent and R. K. Jones tunnel foreman. Assistant tunnel superintendents are: N. J. Shefflett, Apalachia Adit; Oris Holman, Turtletown Adit; M. L. Kelly, McFarland Adit; and Roy Kees, Smith Creek Adit. A. O. Oberson is assistant construction superintendent in charge of the work at the dam and powerhouse, G. E. Smith is master mechanic, J. W. Parker is chief electrician, and C. J. Price is office engineer. Lester Hyland is head blacksmith on the tunnel work and S. J. McJunkin is head drill doctor.

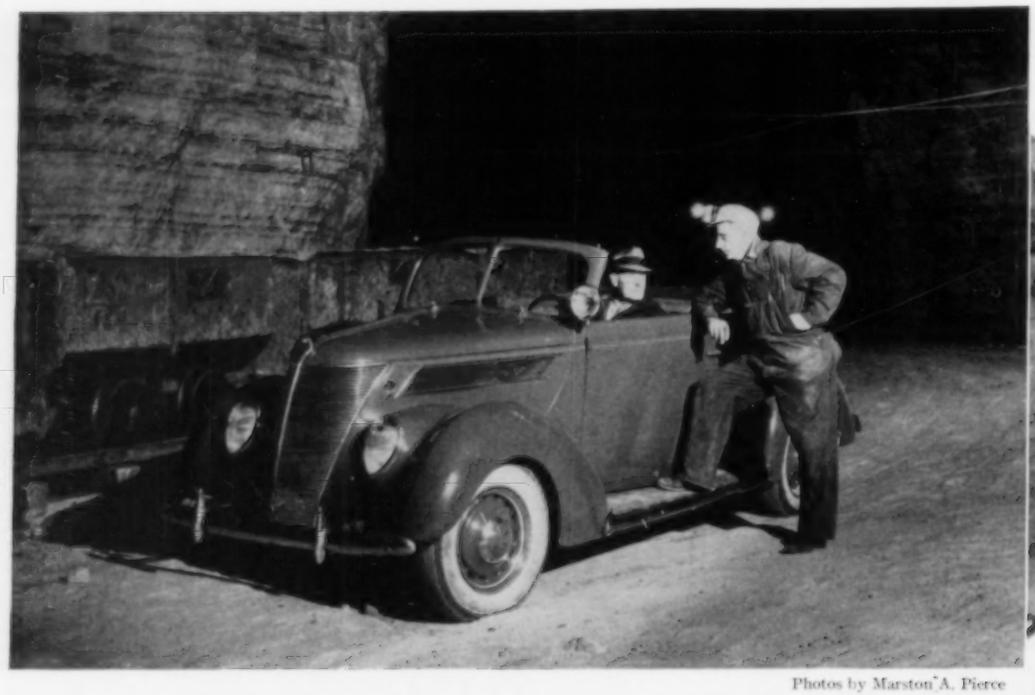
SWITCHING A MUCK CAR

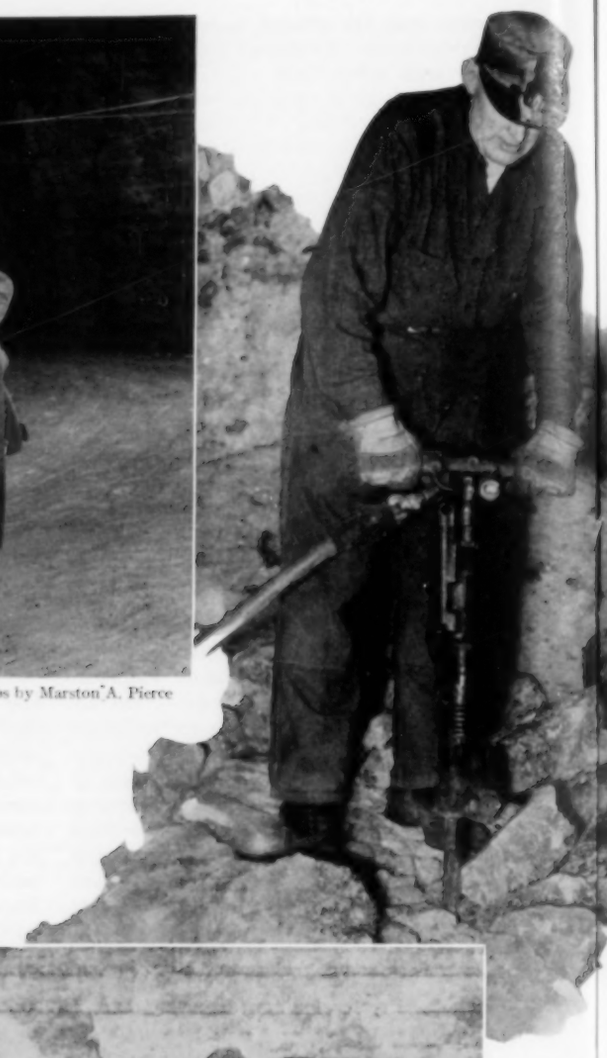
This device is used for transferring an empty car from the rear to the front end of a train during mucking. Short lengths of rails, which fit on top of the regular rails, are mounted on small wheels that run on transverse rails. After the car has been run on to this section it is pulled off to the side of the main track. When the muck train has passed, the car is moved back to the main track, as shown here. It then becomes the head car of the train and is hauled to the heading to be loaded.



SAFETY MEASURES

Coupling bars between muck cars have a handle welded to them to protect the switchman's hand, as shown at the left. Coupling pins, one of which the workman is holding in his left hand, are made in a drill-steel sharpener from discarded pieces of drill steel. The other view shows two of the wooden cars in which explosives are hauled into the tunnels. They have two compartments, one for powder and one for primers, with hinged side covers that can be latched. The TVA record for safety is considerably better than that of the construction industry of the country as a whole.





Photos by Marston A. Pierce

Salt of the Earth

Fremont Kutnewsky

THE Biblical statement, "Ye are the salt of the earth," (Matthew V. 13) was no idle phrase. Primitive peoples were keenly conscious of salt's worth, perhaps more so than we of today who are prone to take most everything that is readily available for granted. To early man, salt represented something that was both imperishable and that would keep other things from perishing. Aside from these qualities, he was aware that it made food good to eat and that it possessed healing powers, which he exaggerated.

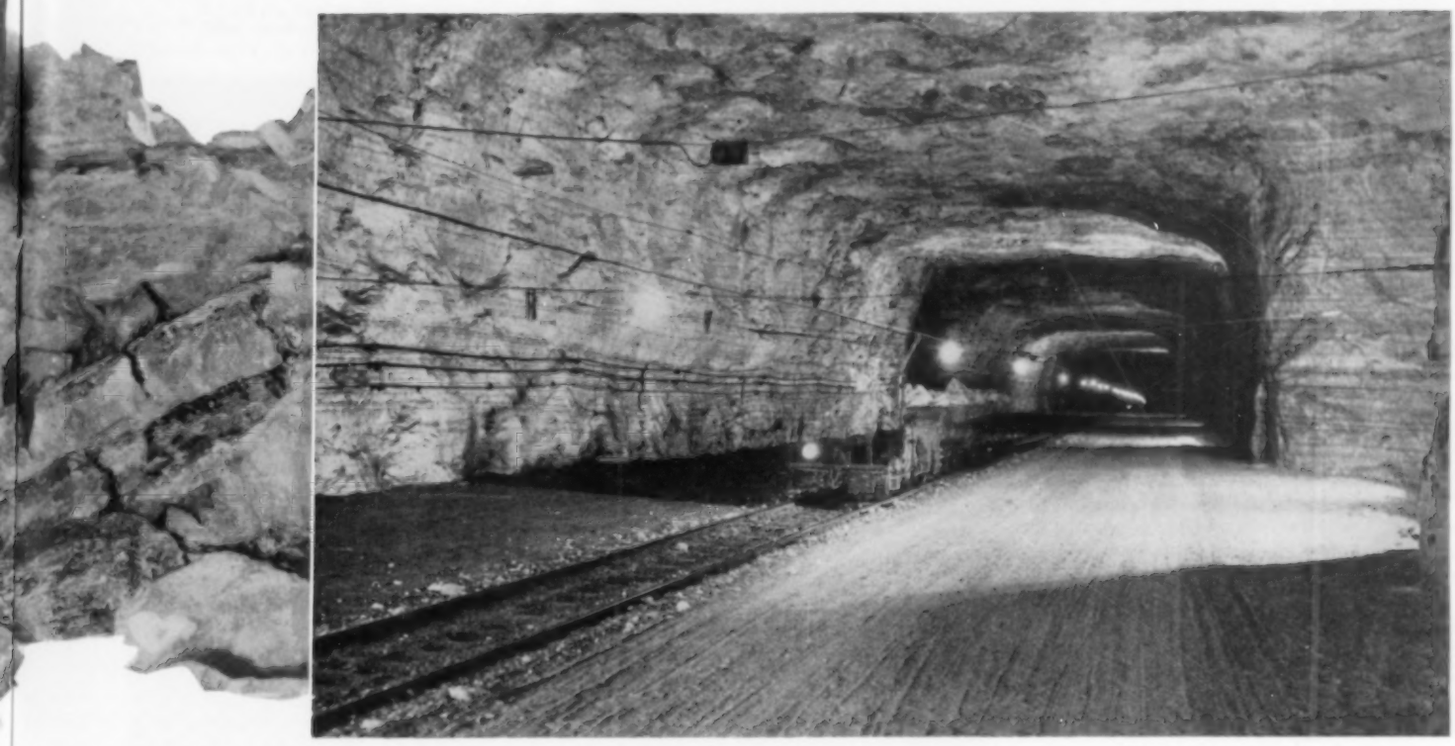
Salt is one of the world's most widely distributed minerals. This is fortunate, because it is essential to life. We are told that the Phoenicians carried cargoes of salt in the ships in which they first ventured across the Mediterranean, and salt is believed to have been the first important article of commerce. Its economic importance in those ancient times is emphasized by the fact that the salt trade not infrequently was a government monopoly, and even to this day some countries in the Far East impose a tax on salt. Roman soldiers were originally paid in salt, which explains the saying that a man "is not worth his salt." Each fighter's allowance was called his *salarium*, or his portion of *sal*, the Latin word for salt. Later, when money was introduced, the term stuck, and we commemorate that early Roman practice in our use of the word salary.

Today, salt's contribution to our needs and well-being is manifold. The per capita production in the United States increased from 97 pounds in 1910 to 151 pounds in 1940. During that period our chemists made great strides in discovering substitute materials for manufacturing purposes, and in that work they found common salt to be of inestimable value to them. In creating new products out of salt and its derivatives they struck a telling blow at Japan's silk industry some years ago by giving us rayon, as artificial silk is generally called in this country. The fabric is manufactured by means of caustic soda, which comes from salt. Our modern plastics that are making history owe their existence to one or another of the well-known salt derivatives and compounds. If this country should, in the not-too-far-distant future, free itself from dependence on natural rubber, it will probably be attributable in part to a synthetic material obtained from coal, lime, water, and salt.

Salt is an ingredient in most of the com-

SALT MINE UNDERNEATH A CITY

Nearly a quarter mile beneath the streets of Detroit, Mich., the International Salt Company operates a salt mine that has been worked since 1907. There are 25 miles of passageways so wide that Mine Foreman Joe Patton (far left) travels them in an automobile. The longest straight stretch (below) extends for a mile and is strung with electric lights. Mining of the horizontal salt bed is done by the room-and-pillar system, the rooms measuring 50x50 feet and the intervening supporting pillars 40x40 feet. The first step in excavating the salt is to undercut the face with a conventional coal cutter (lower left), which cuts a slot 8 feet deep the length of the room. Three lines of blast holes are then drilled at different heights and are loaded and shot. Blasting is done electrically and at night only. After the shot, oversize lumps are reduced with air-operated paving breakers (center).



modities we use in everyday life. Are you wondering how long your automobile will carry on? Its chances of serving you are greatly enhanced by the fact that its bearings and parts have been casehardened with a salt derivative. If your tires wear out and you manage to get them recapped, or you are able to buy new ones of reclaimed rubber, you will have salt to thank, because caustic soda makes it possible at reasonable cost to recover the pure rubber that remains on worn-out tires. There is salt in the steering wheel and other plastic parts of your car, and this is also true of the antiknock in gasoline (if you can get it) that makes your engine last longer.

Your home life has been generously showered with the benefits of salt. Whether you keep foods fresh in an icebox or in a mechanical refrigerator, salt is behind the scenes. The shining chrome edging around your kitchen sink, the smoothly plated cutlery and doorknobs, the gleaming faucet and drinking water that flows from it, the snowy linens that stay white though frequently laundered, the clothing that comes back from the dry cleaner looking and smelling like new, the zeolite water softener and numerous soaps, cleaners, bleaches, cosmetics, and dentifrices—all contain salt in one form or another. If you are bothered by rats or insects and rid yourself of these pests by the use of hydrocyanic gas, or if you clear out a clogged drainpipe by pouring into it something that you get for the purpose at the grocer's, give salt the credit, for these and many other destructive agents are extracted from that common white mineral.

Every housewife knows, of course, that no dish can be made really palatable without salt, that no table is completely set without it. Tasty pickles, olives, and many condiments, relishes, and sauces are prepared and preserved with salt or one of its substances. Baking soda and its compound, baking powder, come from the same source, being obtained in the production of sodium carbonate. It is from the latter that we get our caustic soda and sal soda, and it plays a part in the manufacture of soap and glass. Baking soda (sodium bicarbonate) is the basis of many popular indigestion tablets, and is no feeble antacid in itself.

Flake salt, a variation of table salt, makes pretzels tasty and is used for salting fish, curing ham and bacon, and purifying sausage casings. A great deal of it is required in making butter, as is also granulated salt, the kind you put in the salt-cellar. The latter serves in processing self-rising flour, in baking bread, in making cheese, pickling cucumbers, canning fruits and vegetables, preserving and packing meats, and manufacturing dyes.

The body tissues of both man and beast contain salt, and the supply must be continually renewed to compensate for loss through perspiration. Some foods provide that essential element, but rarely in sufficient quantity. For that reason workers in boiler rooms, foundries, laundries, and in hot places generally, are cautioned to take an occasional salt tablet in order to restore the saline balance of the system. It is well known that "being overcome by the heat" is usually attributable to the fact that the body lacks salt. Blood is saline, so are tears, and doctors sometimes give a saline injection in case of excessive loss of blood. Salt water has many curative uses, too numerous to mention here. Chemically speaking, salt is sodium chloride—a union of metallic sodium and chlorine gas. Upon receiving salt, the stomach changes its chloride component into hydrochloric acid for digestive purposes. The body divides the salt into its chemical constituents with the greatest of ease, but it takes elaborate equipment to do the same thing industrially.

LOADING ROCK SALT

The initial mining operation opens the rooms to a height of 11 feet. Track is then laid and small power shovels (below) load the broken salt into 3½-ton cars that are drawn by electric locomotives to one of the two shafts. After a room has been cleaned out, the track is taken up, more holes are drilled in the roof, and the overhanging material is shot down to a height of 20 feet. Next, the track is relaid and loading is done with large power shovels (left).

The first commercial use of salt was for preserving foodstuffs. Since it kept them from spoiling, primitive peoples thought of salt as a protection against devils and demons. You probably have seen people throw a pinch of salt over the shoulder when they spilt some accidentally. This practice originated in the belief that salt had the power of driving away evil forces and thus warding off bad luck. Ancient travelers carried a little packet of it just as some of us today carry a rabbit's foot.

Down through the years the mineral became a sign of everlasting loyalty and friendship. "It is a covenant of salt for ever, before the Lord," (Numbers XVIII, 19). Elisha threw salt into the fountain of Jericho (2 Kings II, 21) saying: "Thus sayeth the Lord, I have healed these waters; and for the future they shall not be the occasion either of death or barrenness." It was therefore only natural that man of ancient times regarded salt as a symbol of immortality, as well as the purifier and healer that it really is. There is little doubt that *salus*, the Latin word for health, was derived from the root *sal*—salt. Because the latter was essential to the enjoyment of food and was also a token of longevity and a means of propitiating the gods, the Romans placed the saltcellar first on the table and all other things in relation to it. The seat of honor was near the salt. In referring to the cultured Greeks of Athens in her Golden Age the term "Attic salt" came to mean delicate, refined wit.

The alchemists of the middle centuries considered salt one of the three basic elements from which the seven noble minerals originated. Mercury symbolized the spirit, sulphur the soul, and salt the body. Nor were the alchemists far wrong. Salt ranks fifth among the 150 most important materials used by the chemical industry today, being exceeded only by water, air, coal, and sulphur. The brine derived from it ranks eighth. Modern chemists have done what their forerunners of long ago hoped to do. They have broken down salt into its components and from them obtained many new materials such as metallic sodium, caustic soda, chlorine, hydrogen, soda ash, and sodium carbonate. All are immensely important to industry.

Metallic sodium is converted into sodium peroxide, a valuable ingredient in tooth powder and an antacid in mouth washes. And, by the way, if you want to whiten your teeth you'll find salt a very effective agent. Many people use it. By another chemical sleight-of-hand, metallic sodium enters into the production of peroxide of zinc. This goes into bleaching creams and is a powerful deodorant. Still another conversion yields hydrocyanic gas, which is widely employed for fumigating.

Caustic soda is extremely adaptable and is doing a good deal of war work. One of its largest industrial fields is the manufacture of rayon—now the preferred fabric for heavy-duty tires for military vehicles. Soapmakers consume great quantities of caustic soda. Among their by-products is glycerin, which is of growing importance in the manufacture of synthetic resins and drying oils. It is also used extensively in the production of ammunition and explosives. Caustic soda kills the bad taste—sulphur—in mineral oil; eats the fabric out of old tires to free pure rubber; and, as lye, takes the hair off animal hides in the process of tanning. It plays a part in making phenol, from which we get sensitive explosives and dyestuffs. It is an ingredient in paint and varnish removers, destroys insects, softens water. In still other roles it meets a need in electroplating, alcohol rectification, purification of coal and coke by-products, and in the manufacture of pulp and paper.

Chlorine, the other half of the sodium-chloride partnership, has been much in the news since it was placed under full priority on July, 26, 1941. First to feel the effects of chlorine restrictions were the paper and textile mills and laundries. If the paper on which this is printed does not happen to be as white as formerly, that can be accounted for by the fact that chlorine has gone to war. In the first place, the army requires lots of smokeless powder, so chlorine has been drafted to bleach the necessary cotton linters. It also helps to make a smoke-screen substance.

The bleaching qualities of chlorine are attributable to its affinity for hydrogen. Since the latter is a key coloring agent for organic materials and readily combines with chlorine upon contact, chlorine is a favorite bleach in many industries. It is indispensable for a wide variety of clean-

ing jobs because it removes what is not wanted. It purifies pharmaceuticals, extracts fat and oil from soybeans, nuts, grains, feathers, and slaughter-house tankage. It sterilizes sewage and makes drinking water safe for public consumption. To chlorine belongs much of the credit for eliminating typhoid from the list of diseases that once seriously threatened centers of population.

In several forms, under the head of chlorinated hydrocarbons, chlorine is the base of solvents that have made modern dry cleaning possible. These solvents remove the fats and oils that are responsible for most stains and are safe to use on all kinds of fabrics. They are not flammable. On the contrary, your fire extinguisher most likely contains one of these liquids. Chlorine performs an important service in the extraction of bromine from sea water, and in another guise it shows up in Freon, a cooling agent for household and commercial refrigeration and air-conditioning systems.

By treating salt and sulphuric acid in a certain way chemists obtain salt cake, or sodium sulphate, which Johann Rudolf Glauber discovered 300 years ago and which goes under the name of Glauber's Salt. Glauber thought that he had found the long-sought universal solvent and panacea for all human ills. He cited 26 uses for his salt in medicine, 21 in the arts, and twelve in alchemy. Before the day of priorities, the kraft-pulp and paper industry absorbed 70 per cent of the sodium-sulphate output of this country. If we have to carry our groceries home in old-fashioned net instead of brown-paper bags it will be for the reason that sodium sulphate can do its share in fighting the Axis powers. Further, there is a demand for it in glass making, ceramic glazing, and in manufacturing other sodium salts and detergents.

Hydrochloric acid, commonly known as spirits of salt, is a by-product of salt cake. A good deal of it is used in making synthetic rubber such as Neoprene, Koroseal, and Flamenal. It cleans steel and wire for galvanizing, enters into the production of solid carbon dioxide (dry ice), and helps to give us glucose, synthetic perfumes and dyes, as well as wood alcohol. It is used in tanning leather and in the manufacture and refining of sugar. Soda ash is another of salt's prolific offspring, and finds application in making glass, soap, chemicals, cleaners, pulp and paper, water softeners, boiler compounds, and in oil refining.

If the war causes a shortage of some of the things that we have been buying at the corner drugstore, salt may serve as a substitute. For example, there is no better gargle for sore throat than salt and water. During the first world war doctors recommended it to men at cantonments as a safeguard against influenza. And, as mentioned earlier, salt is a good dentifrice and is improved by baking soda.

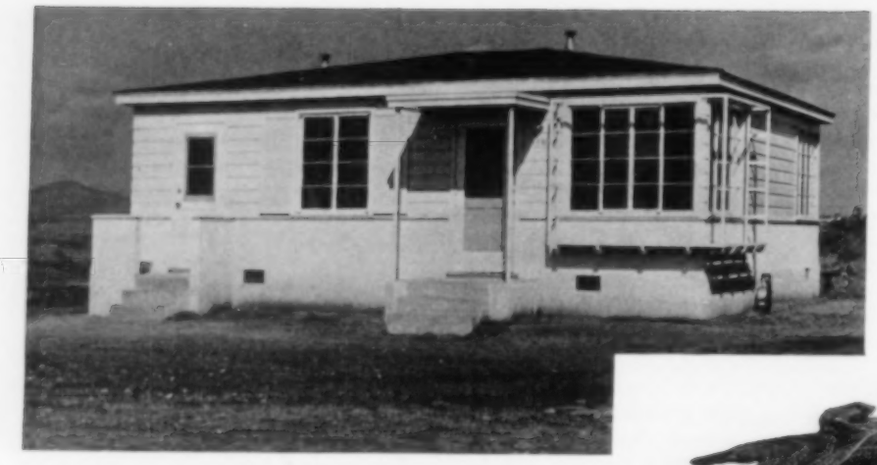
Recent experiments have shown that salt is as effective as sand for smothering incendiary bombs, and it is possible that great amounts of it will be called for in America's preparations against air raids. Salt has several advantages over sand from the viewpoint of city dwellers. It comes in bags or boxes in almost any desired quantity from 1 pound up, whereas sand is commonly available in only 100-pound bags.

The oceans contain 4,800,000 cubic miles of salt—enough to cover the continental United States a mile and a half deep. In addition, the earth has a reserve of approximately 325,000 cubic miles, and the mineral is found in nearly every country. The supply in the United States is well-night inexhaustible. In some localities salt deposits are mined through shafts by methods similar to those used in extracting coal. In other sections wells are put down and the brine is pumped out and evaporated. There are some natural brine reservoirs, but generally it is the practice to circulate water through dry salt beds and to pump the solution to the surface. Salt is also obtained from saline lakes by evaporation.

Salt was first discovered in the United States near Syracuse, N.Y., and its production began in 1788 or 1789. History has it that the Indians sold it to American settlers as early as 1670. Rock salt was found at Avery Island, La., in 1862. It proved to be of strategic value to the Confederate side during the Civil War because the South was more or less effectually blockaded and had to depend on its own resources. Today, this country leads the world in output and consumption, accounting for 35 per cent of the total annual production of 29,000,000 short tons.

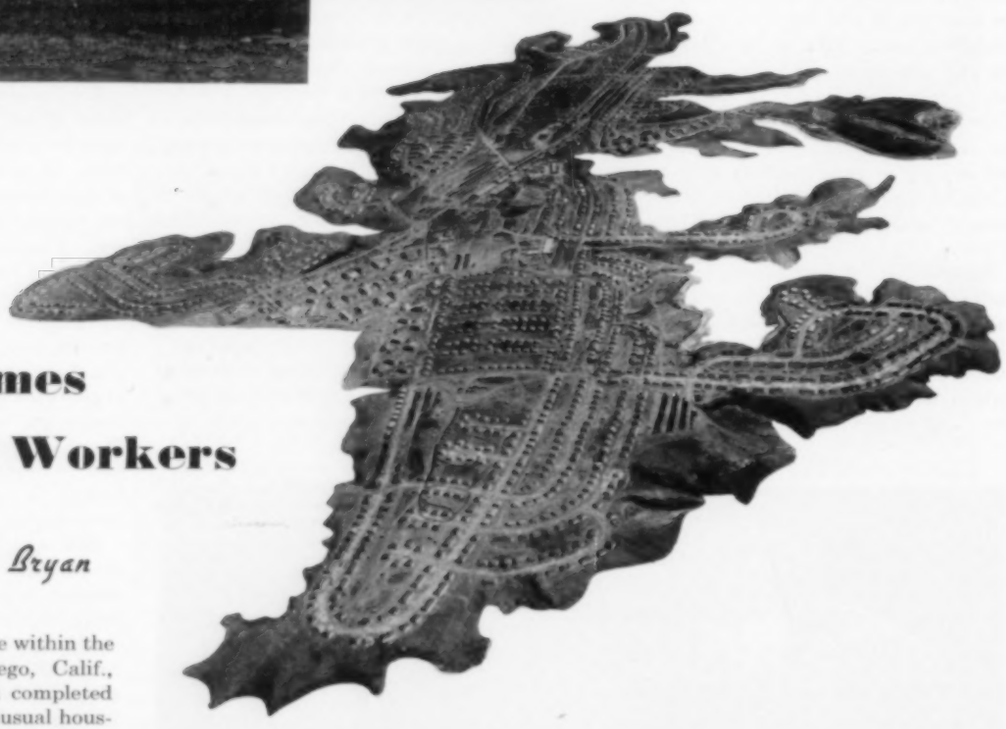
FINISHING OPERATIONS

The mine produces about 1,700 tons of salt daily. After being hoisted from underground, the raw material passes through a primary crusher and then on to a picking belt from which women workers remove blasting wires, gypsum, and other extraneous matter (above). The salt is then reduced to the several sizes in which it is marketed and stored in separate bins. From these it is drawn into bags that are shipped to the distributors. Those pictured contain rock salt and weigh 100 pounds each.



GROUP OF 1,704 HOMES

Below is an aerial view of Linda Vista, a Government-sponsored housing development for factory workers in San Diego, Calif. The improved tract is a mile wide and ranges up to two miles in length. The structures are of 36 different designs. At the left is one of the prefabricated dwellings. The cost of the project totaled $9,000,000, or an average of $3,000 per family unit.



Modern Homes for Aircraft Workers

Robert N. Bryan

ON A 1,300-acre eminence within the city limits of San Diego, Calif., there has recently been completed one of the largest and most unusual housing projects in the country. This development, called Linda Vista, was created to provide homes for thousands of new employees that were urgently needed in the expanding aircraft industry. Since the dwellings were intended for occupancy by defense workers, the undertaking was supervised by the Public Buildings Administration, a branch of the Federal Works Agency.

Linda Vista is aptly named. Translated, the words mean "Pretty View," and the name is most appropriate. Every geographical advantage of the site has been utilized by the far-sighted PBA planners on the theory, no doubt, that pleasing home surroundings are a definite aid to morale. West of the project is the Pacific Ocean. To the south lie sparkling San Diego Bay and the city itself. To the north and east are the colorful San Bernardino Mountains—the same range that sweeps majestically through the desert regions adjacent to the area.

To the McNeil Construction Company and the Zoss Construction Company, both of Los Angeles, was entrusted the building of the project. The McNeil organization is the oldest of its kind in southern California, having been in continuous existence since 1886. This company has to its credit numerous manufacturing plants and structures in Los Angeles and vicinity. The Zoss organization, formerly Sarver & Zoss, also is well known, having erected many post offices and other public buildings.

Linda Vista represents a completely planned community for 3,000 families, and facilities have been provided for 13,000 people. Among the conveniences is a commercial section which includes stores, a theater, administration buildings, and maintenance shops. A well-equipped hospital also has been constructed, as well as two elementary schools, a high school, parks, playgrounds, a sewage-disposal plant, a water system, and a modern electric substation. Streets are macadam surfaced, have concrete curbs, and are lighted.

The project water system connects with the city supply in Mission Canyon. Water is delivered to a 5,000,000-gallon reservoir within the site and thence distributed to the buildings. The laying of the sewer and water lines presented problems not ordinarily encountered on jobs of this kind. For example, during one period of unusually heavy rains it was necessary at certain places to scrape off 6 feet of mud to reach solid ground. Once trenching began, however, the ground was so hard that it challenged the capabilities of the numerous machines used for that operation. All in all, 57 miles of sewer and 46 miles of water lines were dug, and of the total 103 miles approximately 97 per cent was drilled and blasted.

In one period of 93 working days was excavated 45 miles of trench—an outstanding achievement in view of the fact that the conduits were laid at the same time. Superintendent of Utilities E. L. "Dude" Brannon of the McNeil Company made extensive use of compressed-air power throughout these operations. Seventeen Ingersoll-Rand Mobil-Air compressors were employed, the units furnishing air for many Jackhamers, paving breakers, and backfill tampers. Detachable Jackbits of the Carr type were used

for drilling, and their cutting edges were renewed by an electrically driven Jackbit grinder. Actual building was started during the early months of 1941. At the outset, an observation tower was placed on the site, and shortly thereafter the contractors installed a motion-picture camera. Then the job was filmed from time to time to show progress. By September 15, 1941, the major work had been completed, far ahead of schedule.

To understand the magnitude of the project, one must realize that Kearney Mesa occupies an area more than 2 miles long and at certain points a mile wide. The main axis follows the north-south ridge of the plateau. West, south, and east, the approaches are too steep to encourage the encroachment of speculative developments that might endanger property values. The planning was done with a skill and thoroughness unusual in an undertaking of this size and character.

The gently rolling topography of the site made it possible for the architects and engineers to avoid a regimented housing plan. The main circulatory roads follow the general contours of the land and thereby form "super blocks." Access to units within a block is by local streets, of which some are cul-de-sacs. In general, Kearney Mesa soil is shallow, and by clever allocation of the dwellings the amount of cut and fill work was held to a minimum.

The Linda Vista houses incorporate many architectural features common to southern California. It was necessary, however, to keep within the cost limitations set by the Lanham Act, which authorized the project. The Act stipulates that shelter costs must average $3,000 a unit. In spite of this fact, housing standards of the USHA (United States Housing Authority) and the FHA have been exceeded in Linda Vista homes.

The houses in the development are of 36 different designs, and to add to the variety and at the same time to minimize the cost of utilities the planners determined upon four general types of buildings. Of these, 1,184 are single-family structures, 237 are built for two families, 178 for four, and 105 for six. To accommodate both large and small households, some units have one bedroom, others two, and still others three. The living rooms are spacious, and each includes a dining alcove. The kitchens are furnished with a stove, sink, washtub, electric refrigerator, and metal storage cabinets. Heat is supplied by gas heaters of the circulator type.

For the first time in such an extensive project, oak (hardwood) flooring is found in all the houses. The dwellings themselves are of wood-frame construction, with concrete foundations and exteriors of redwood or of colored stucco. The low-pitched roofs are covered with asbestos shingles, and steel sash is a feature of all windows. Many parts of each building—walls, flooring, ceiling sections, plumbing units, and standard electric systems—were prefabricated before being trucked to the sites. There they were quickly assembled by expert crews of workers.

In the building of the houses, materials were used in such quantities that the totals seem well-nigh incredible. Some conception of the enormity of the undertaking can be gained from the following figures: 103 miles of water and sewer pipe, 24,000,000 board feet of lumber, 24,000 doors, more than 20,000 lighting fixtures, 2,500,000 square feet of hardwood flooring, 96,000 gallons of paint, 315,000 panes of glass, 810,000 square yards of lathing and plastering, 3,500,000 square feet of roofing, and 20,000 kegs of nails, the latter weighing in excess of 2,000,000 pounds.

The Kearney Mesa housing development is a far cry from the type that sprang up in former eras under similar circumstances. Today, the comfort, well-being, and morale of defense workers are of paramount consideration. The Government believes—and wisely—that no man can put forth his best efforts unless his home environment is clean, comfortable, and worthy of pride. In Linda Vista the bunkhouse is a thing of the past, for the community represents the high standard of living to which America and Americans have become accustomed.

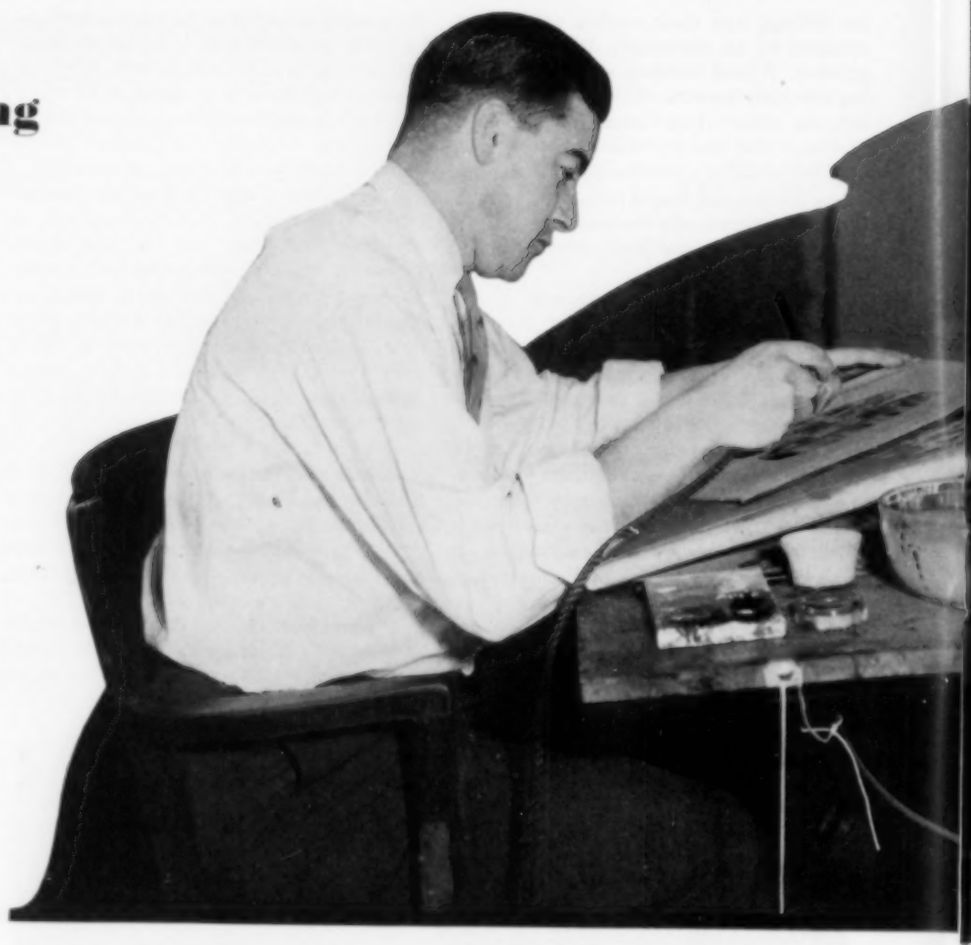
Photos, Federal Works Agency

CONSTRUCTION SCENES

The development occupies an elevated area known as Kearney Mesa. A great deal of excavating had to be done to provide a water-supply reservoir and other utilities. Some of this work is in progress in the picture above. The laying of 103 miles of water and sewer pipes called for extensive trenching, 97 per cent of which entailed drilling and blasting. Seventeen Ingersoll-Rand portable compressors and numerous rock drills, paving breakers, and backfill tampers were employed for this and similar operations. Two of the compressors are shown at the right.

The Magic of Photoretouching

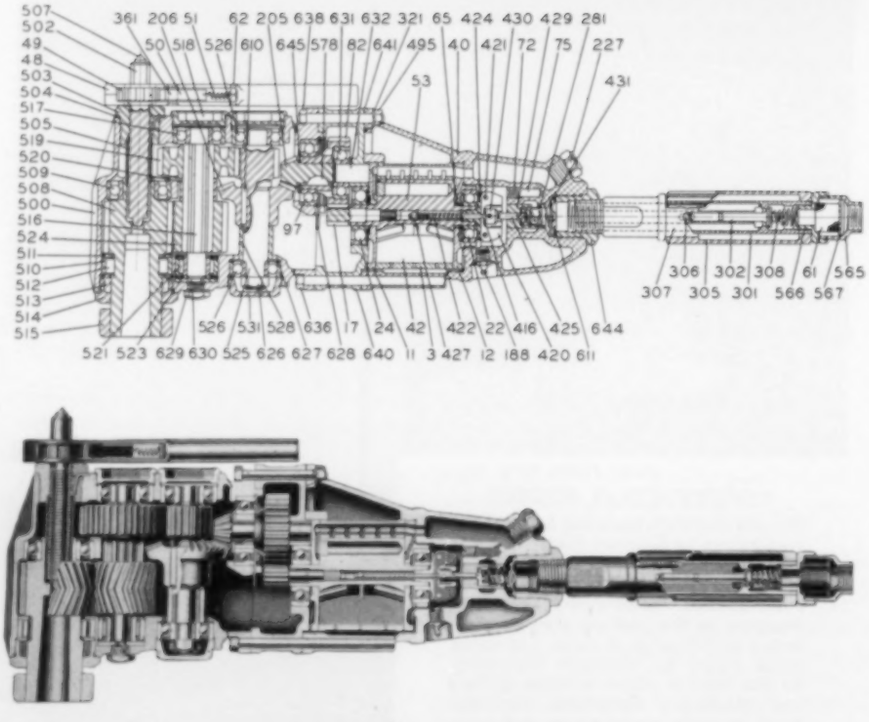
J. F. Nesbitt



WITH the acceleration of travel and communication, our individual horizons have receded. New and varied interests crowd our leisure moments, and the tempo of our lighter reading has quickened. Pictures are being used in ever-increasing numbers to augment the printed word and, in many instances, to convey messages unassisted. Tabloid newspapers and picture magazines, mere tyros in the publishing field, have grown with mushroomlike rapidity, and are already challenging the long-standing leadership of their older and wordier contemporaries.

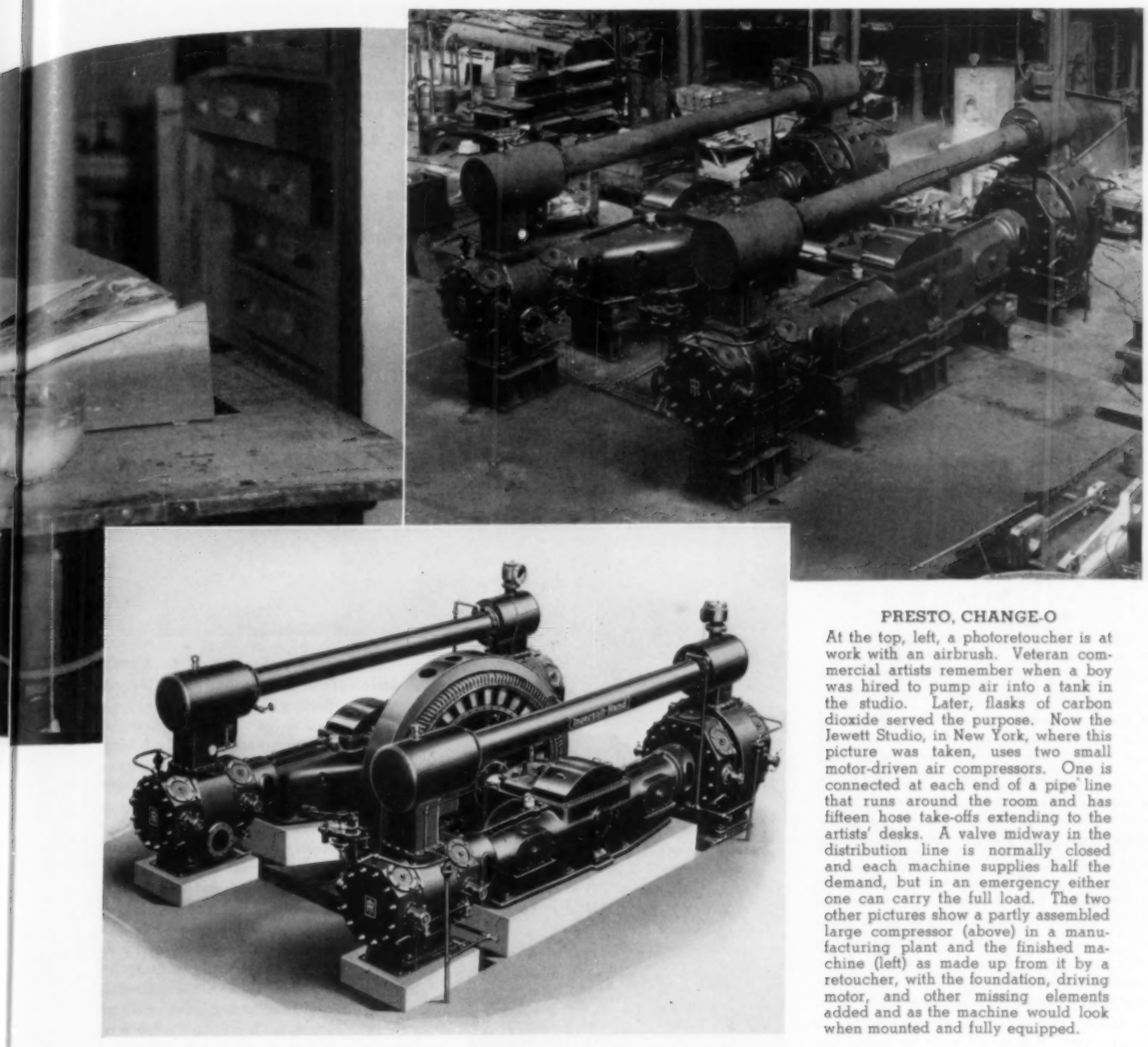
Like many of the wonders of our modern civilization, the printed photograph has become so much a part of our daily lives and habits that it is generally taken for granted. Looking at it in newspaper, magazine, or booklet, few of us ever stop to wonder how it got there. Yet its transition from actuality to the printed page uncovers a whole group of highly technical industries in which the picture moves in progressive steps. Starting with the original negative, it is reproduced on sensitized paper, then photographed through a screen on a wet-plate negative and transferred as a combination of tiny dots on to a metal plate, finally emerging as the finished product on paper through the medium of printer's ink. It is a story of specialized skill, and its principal characters are the photographer, the retoucher, the engraver, the electrotyper and, last, the printer.

The photoretoucher is probably the least publicized member of the cast because his work, when most effectively done, is seldom detected in the finished printed picture. By the magic of his art the weak out-of-focus photograph is sharpened and strengthened; the dark overexposed photograph is lightened; blemishes and unwanted elements are eliminated; missing parts are inserted in their proper places; perspectives, distorted by the camera, are corrected; the uncompleted, unpainted machine is polished and finished, etc. And all this is done with such smoothness, precision of detail, and finesse in the matter of matching and blending color that the naturalness of the photograph and the delicate balance of its tones are left undisturbed. It is an art that is as important as the photography itself, bridging, as it does, the gap between the potentialities of



SIMPLE—IF YOU KNOW HOW

It is quite a task to cut apart a tool to show its insides, but a skilled retoucher can do the job very nicely, as the two illustrations immediately above prove. The upper one is an assembly drawing of a Multi-Vane air drill numbered for reproduction in a parts list distributed to users. From that drawing an artist prepared the lower sectional view of the tool.



PRESTO, CHANGE-O

At the top, left, a photoretoucher is at work with an airbrush. Veteran commercial artists remember when a boy was hired to pump air into a tank in the studio. Later, flasks of carbon dioxide served the purpose. Now the Jewett Studio, in New York, where this picture was taken, uses two small motor-driven air compressors. One is connected at each end of a pipe line that runs around the room and has fifteen hose take-offs extending to the artists' desks. A valve midway in the distribution line is normally closed and each machine supplies half the demand, but in an emergency either one can carry the full load. The two other pictures show a partly assembled large compressor (above) in a manufacturing plant and the finished machine (left) as made up from it by a retoucher, with the foundation, driving motor, and other missing elements added and as the machine would look when mounted and fully equipped.

the photographic print and the requirements of the reproduction process.

There are few photographs that do not need retouching owing to the difficulties that beset the photographer and the mechanical limitations of his craft. Shop views, for instance, or photographs of installations where machines are arranged for working efficiency rather than picture composition, are adversely affected by inadequate facilities, poor lighting, cramped quarters, and a score of other insurmountable obstacles. In news shots and haphazard action pictures, the photographer must make the most of conditions as he finds them, and the results are usually far below the standards that insure satisfactory reproduction. Even the planned advertising photo originating in the studio, with all its paraphernalia, requires spotting, lining, or separation. Arc lights cast double shadows—highly polished metal surfaces pick up hard black reflections—colored surfaces do not always photograph in black and white in their proper relation to other surfaces.

The retoucher supplies the antidote. His chief tool is the airbrush, which is a misnomer because it is not a brush at all and does not, at any time, come in contact with the photograph on which he works. It is really a miniature spray gun with such delicately controlled action that its operator can produce at will a tiny dot, a thin line, faint tint, deep shadow, smooth tone, or a coarse spatter texture.

About the size of an ordinary fountain pen, the airbrush is operated by means of compressed air. A small paint cup or reservoir, attached to its side, is conveniently placed and shaped so as to facilitate the frequent changes of color necessary to match the myriad variations of tone in the average photograph. The paint is drawn into the air stream, atomized, and ejected as a barely visible stream of vapor the size, force, and density of which are controlled by adjustment of a needle valve and manipulation of a trigger. In the hands of the expert, it is truly a magic wand, although its wielder, in place of the age-old "presto," relies upon a more substantial, mundane formula—visualization, artistic ability, mechanical skill, and an intimate knowledge of the possibilities as well as the shortcomings of the graphic-reproduction processes.

PROFITS FROM WORMS

Everywhere in the United States there are persons who support themselves or add to their incomes by dealing in fish bait. The most-used live lure for fresh-water angling is the common earthworm, and its sale run into billions annually. Prices vary. In New Jersey a small tumblerful of the writhing creatures retails for 50 cents. Some merchants raise their own supply. If there are chickens around, old bedsprings (left) are good for keeping them off the worm garden. Worms like a cool spot, with large rocks that keep the sun off and the moisture in the soil (below). They are not fastidious; in fact, they prefer a messy looking home such as that shown at the bottom.

I *Never* Fish with Worms

Carey Holbrook

I NEVER fish with worms! If a fellow can't take his fish with a fly, or a bucktail, or a spinner, or a bent-tailed wobbler, he just naturally ought to stay at home and help his wife wash. I don't mean that a fisherman should travel 40 miles up into the mountains and not have a worm or two along with him. He might run across a starving mockingbird and not have a dang thing in his box to feed him. Certainly he should take along a few good energetic worms, just in case, especially when worms can be turned up by the dozen any place and anytime—except the day when he wants to go fishing.

All you've got to do on the morning of your fishing trip is to step out behind the barn and dig up every yard of earth from th corral fence to the lower end of the cow pasture. Then, if you still have strength enough to drive, you run down the road a piece and buy your worms from a fellow who has had sense enough to hoard 'em. You won't have to travel far. It's a long lane that has no worm merchant in it. Of course your acute worm shortage occurs only on the days when you want to go fishing. Any other time all you've got to do is stick your spade in the ground, and the worms you turn up will chase you out of your own field.

Every school child knows that earthworms never change into millers or moths; once a worm, always a worm. And regardless of who told you, a worm can neither see nor hear. During heavy rains worms will climb on rocks to avoid being drowned, but if they remain in dry hot places they will die, since the membrane of their skin serves as lungs and must be kept damp if they are to survive. Darwin gives earthworms credit for being man's first soil conditioner, claiming that they add a fifteenth of an inch to it annually. Not only do they do that, but they reduce soil irregularities by making paths for new plants and tunnels for air and water as they burrow.

These hermaphroditic, limbless, creeping, invertebrate creatures move along by contraction of a double row of bristles on the underside of the body, having two sets of muscles, one lengthwise and the other encircling the body. Where the earthworm has it all over us humans is that it may be both masculine and feminine. This morning the mama worm may take a notion to lay a couple of thousand eggs: tonight she might decide she ought to be the papa, so she gets a clean shave and goes out wigwagging with a lady friend. That's what Darwin says about the worm. He doesn't say anything about using it for fishing, and I never do. It ain't sporting.

I didn't have any intention of breaking my rule about worms that day I was fishing up on the Penas Negras. All day long I had been rotating my flies, pitching a gray hackle in this pool and a dusty miller in the next, hoping I could interest a trout in what I had to offer. But I couldn't, and I felt pretty discouraged when I finally sat down to rest close by a pool high up in the canyon. You know the Penas Negras hits this canyon about a couple of miles from where it empties into the Rio de las Vacas, and along that stretch are boiling bits of white water that leap and snarl at the rocks. Below each riffle are blue and smiling pools, deep as the heart of a woman, cold as a banker's glance, mysterious as a magicians rabbit, and peaceful as a brindle bull under a cork tree. And I felt pretty peaceful myself. I was just as surprised as the next fellow when I reached back to find that that hard lump in my hip pocket was a tobacco can practically filled with as slimy a lot of red worms as you would want to see. I guess my wife must have left them there the last time she wore my pants. Dang women anyway!

I know she did not dig them herself, and she probably got them from the same merchant who told me that worms did not breed until after the freezing period—say between April and September. The eggs are covered with a little hard capsule and deposited into a cocoon affair. Before she gets ready to lay a batch, the old

mama worm looks like she's wearing a girdle around her middle—like she might have been cut in two with a hoe and then sewed together again. But that girdle is her maternity belt. So far as being cut in two is concerned, it wouldn't bother Mrs. Worm any. Both ends of her would go ahead and grow, so there would be two worms instead of one.

Maybe that was what happened to the worm I picked out of the tobacco can. He was long and well filled, so I just threaded him on my hook and tied a cork on the line. I never have figured how that cork happened to be there, unless it flew out of some bottle and accidentally landed in my fishing box. But, anyway, after I had tied on a chunk of lead right above the leader, I heaved the whole mess into the pool and leaned back to rest. I was pretty bitter about the whole thing by this time. A fly fisherman just can't have a bunch of worms following him up the creek without becoming a little soured on things. For a long time nothing happened, and I began to ponder on what a worm merchant had once told me.

"There is a difference in worms," he said. "I've got the kind a fisherman can depend on—energetic, full of fight. I like to work my worms up to a pitch where they will snap at me when I poke a finger near their box. You see I feed 'em well," he went on, "raw meat, cabbage, onions, and milk. This dried milk is fine to put a worm in shape to do his best work. Make a quart solution about once a month and pour it over them. Keep the top of your worm bed covered so the chickens can't get to them. Feed 'em good and they'll stay with you and be contented. They're human just like you and me, and the worms I turn out are always ready to get right in there and try their hardest to lure a fish."

I kept thinking about what this fellow had told me, and had about decided that my wife must have bought those worms from the wrong merchant, because nothing happened. Lightly as the kiss of a virgin the cork rode on the sparkling bosom of the water. Across the pool a skunk made her way up the side of the mountain followed by six kits exact duplicates of the mother. A water bug skimmed across the pool, took a good look at the cork, and glided on. Higher and higher climbed the sun. Still nothing happened. "I always feed 'em right," I muttered bitterly; "my worms are right in there trying." I guess I must have dozed off for a moment, for when I opened my eyes to look down at the pool there was no cork in sight. Moreover, the tip of the pole was down in the water and jiggling around like a jay with a jag. Well, sir, I didn't lose any time, and with a yell that rattled the ridges I grabbed that pole and brought the whole mess out of the water. First came the cork, breaking the surface with a shower of drops, then the sinker and the leader, followed by the mightiest trout a fisherman ever saw! Out of that pool he came sidewise with a whoosh that could be heard over in Cline's Corners. The yank also brought out every stray limb and rock in the bottom of the pool, and the whole business landed in a tangle of raspberry bushes halfway up the mountainside, with me right on top of it. Boy was that a trout! Seventeen inches he measured from tip to tail, and I got him out with one jerk. Did I give him a chance by playing him along until he was tired? Hell, no! It took me half an hour to dig the hook out after I had carried him a hundred yards from the creek.

I never fish with worms. But if I ever do happen to get another worm on my hook accidentally, I want to be sure that he is a well-raised, hermaphroditic, limbless, creeping, invertebrate that has been trained to put his heart in his work. And I know just where a guy can buy that kind.

Acidizing Oil Wells by Air Pressure

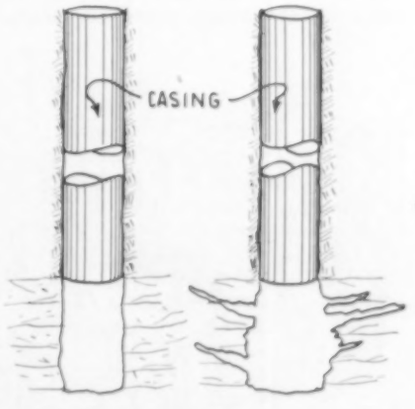
THE practice of injecting acids into a newly drilled well to stimulate the output of petroleum or natural gas is not new, for it was mentioned by Frasch back in 1896. In 1932, research engineers of The Dow Chemical Company, at Midland, Mich., gave great impetus to acidizing by developing chemicals which, when added to the acid solvent, prevented the corrosion of the well equipment. Since then the method has been adopted by nearly every oil and gas field in the United States and has enabled operators to drain from limestone formations vast reservoirs of oil and gas that otherwise would have remained untapped.

The basic principle of acidizing is quite simple and depends upon the chemical reaction of hydrochloric acid on limestone. When a quantity of hydrochloric acid is poured down a newly drilled well into the limestone formation, which is the natural reservoir for oil and gas, chemical reaction sets in and dissolves the lime structure with which it comes in contact. This tends to create a basin at the bottom of the well. However, to be most effective, channels must be opened and enlarged in all directions from the basin so that oil or gas may flow in of its own accord. To accomplish this, acid must be forced into the surrounding limestone. Operators in different fields have learned by repeated tests during the past three years that the most efficient method of penetration is that which makes use of compressed air.

By means of modern air-pressuring, the required amount of hydrochloric acid—100 to 1,000 gallons, depending upon the formation—is injected into a well and the casing head (top) is fitted with a special check valve to prevent the by-passing of air. A pipe, capable of withstanding a pressure of 1,000 pounds per square inch, connects this valve with a compressor. The machines used for the purpose are generally of the stationary gas-engine-driven type that is commonly found in oil fields. The air is forced down the well upon the acid, and the gauge valve at the casing head is watched carefully as the pressure rises. During the first 24-hour period an average of 1,000 cfm. per vertical foot of lime structure is applied, normally building up a pressure at the casing head ranging from 250 to 500 pounds, or sufficient to force the acid the desired distance. So far as possible, this pressure is maintained until the acid has been chemically destroyed by contact with the limestone. The pressure is then released, and the acid-lime residue (calcium chloride) is pumped out of the well.

The length of time it takes the air-impelled acid to spend itself depends upon the structure and formation of the limestone. One treatment is usually enough to bring a well into peak production, although in some cases it is necessary to resort to intermittent acidizing over a period of weeks. In many of the Ohio and Pennsylvania stripper oil fields, where the formations are seamy, less pressure is needed to force the acid into pay rock. There, diesel-engine-driven compressors are used for air-pressuring. In other sections, where excessive air pressure is required and has to be confined within definite limits, packers are placed at various depths in the lime structure and air is sent down the well through 2-inch-diameter tubing.

The use of air in forcing acid into limestone formations virtually eliminates the pumping equipment formerly utilized for the purpose, and in more than 70 per cent of the cases there is a substantial reduction in time and labor. Another important factor is that the pressure under which the acid is driven out of the basin at the bottom of a well can be regulated to meet the needs of the particular lime structure, thus bringing about peak production of oil or gas.



EFFECT OF ACID

At the left is the bottom of an oil well in a limestone formation as it appears after drilling. The other sketch shows how acid treatment opens up channels that facilitate the flow of oil to the opening.

Log of Our War Economy

THE following paragraphs contain significant bits of information culled from official press releases sent out by the War Production Board.

MARCH 25—Local transit and railroad companies were prohibited from substituting buses for street cars except where specifically authorized to do so. The action was taken to conserve buses for troop transportation and essential civilian movements.

MARCH 31—The use of iron, steel, and zinc in the manufacture of cooking utensils, kitchenware, and nonessential household articles was curtailed by from 10 to 50 per cent.

Prices of Pennsylvania anthracite coal were frozen at existing levels.

APRIL 1—Purchasers of collapsible tubes of tooth paste and shaving cream were told that they must hereafter turn in an empty tube for each new one bought.

APRIL 2—Plans for coöperation by industry in a national nutrition program were announced. The slogan will be "U.S. Needs Us Strong—Eat Nutritional Food."

To discourage hoarding of scrap metals, Leon Henderson declared that prevailing prices would not be raised later.

APRIL 3—Manufacture of retreading materials for a limited number of tires from reclaimed rubber was authorized. The tires will be allotted to workers in defense industries.

By restricting deliveries, ice-cream manufacturers hope to make their transportation facilities last 30 per cent longer.

Manufacturers of office machinery were limited to producing machines necessary to meet Army, Navy, and other governmental requirements.

The value of machine tools, presses, and other metal-working machinery shipped during February was given as $93,100,000.

APRIL 4—The jewelry industry was given until May 15 to use up all copper on hand that has been plated or alloyed with gold or silver.

APRIL 6—Manufacturers of cigarettes were ordered to cease using lead foil in their packages after May 1, regardless of how much material they have on hand. The use of lead in buttons, costume jewelry, novelties, and trophies was also prohibited.

APRIL 7—Donald M. Nelson said that within three months all manufacturing of consumers' durable goods using critical metals would be stopped and that the plants, men, and facilities would be converted to war work.

Commitments for war supplies and equipment since the bombardment of Pearl Harbor total $20,892,000,000. From June, 1940, to March 1, 1942, they amounted to $81,835,000,000.

The kinds of soup that can be packed in cans after June 30 were specified, as well as the percentages of solids such soups are to contain. Only the No. 1 picnic or larger cans may be used for the purpose.

Leon Henderson urged everyone to buy next winter's coal now, predicting that by next fall the railroads and truck lines will be fully occupied with war shipments.

APRIL 8—Deliveries of loofa sponges were restricted. These come from plants now grown almost exclusively in Japan, but will be cultivated in this country. Loofa sponges are used for inner soles of footwear and as cleaners and scrubbers in households. They have the property of absorbing oil and are used by the Navy for oil filtration.

Government spending for war purposes was at the rate of $114,900,000 daily at the end of March. This was an advance of 15 per cent over February.

APRIL 9—Nonessential construction of buildings that use war materials or equipment was limited to $500 for residences, $1,000 for farm buildings, and $5,000 for any other form of structure.

Tire-rationing boards were instructed no longer to post the names of Government intelligence officers who receive tires and not to include them in the lists given to newspapers.

APRIL 12—Rationing of typewriters was postponed from April 13 to April 20 because the necessary forms were not available in some sections. The stock of machines on hand for eligible purchasers consists of 100,000 new units, mostly portables, and 750,000 standard-size, used machines.

Production of medium and heavy trucks for civilian use was ordered discontinued after existing quota allotments are completed. Passenger buses of certain types are not affected.

APRIL 13—The supply of chlorine for civilian use was restricted. In view of the resultant curtailment of bleaches, it was predicted that we will return to the old-time method of whitening clothes by washing them thoroughly and exposing them to sunshine. Commercial laundries will henceforth receive only 10 per cent of their usual amounts of chlorine.

APRIL 14—Officers of an Indiana motor-sales firm were convicted on eight counts under the first indictments growing out of the tire-rationing program. They admitted making a false report on the number of tires the concern had on hand on December 12.

It was announced that the salvage of wastepaper was enabling paper mills throughout the country to meet current orders but that little scrap rubber was being turned in.

By limiting the amount of shellac available to manufacturers the WPB automatically reduced the output of phonograph records and radio transcriptions to 30 per cent of the 1941 production.

The WPB announced that manufacturers of mining machinery would be allotted about $50,000,000 worth of materials during the quarter ending June 30. This will insure a steady flow of equipment to mines and smelters producing strategic metals. Under present regulations, priori-

"Hey get off! This is heavy enough without you on it."

"Now, for the last time, did you leave that Jackhamer out in the rain?"

"I don't care how much you've been reading about the Mount Rushmore Memorial, Hawkins. This is a road job."

ties will not be granted to mines whose output in dollar value runs to as much as 30 per cent gold or silver.

APRIL 15—Predicting more walking for all of us, the Government urged greater care in buying shoes to insure a good fit. Suggestions as to the proper care of shoes to make them last longer were also made.

The American Red Cross was designated to collect and return for reprocessing the wool obtained in trimming the cuffs from men's pants made before the ban on cuffs. The 19,500,000 trousers on hand are expected to provide material for 300,000 additional suits. Men were given the assurance that the wartime suits and overcoats will not differ radically in appearance from those now worn.

Two midwestern firms that shipped aluminum for nonwar purposes were prohibited from doing business in aluminum for four months and three months, respectively.

Declaring that production lines are battle lines, Donald M. Nelson urged more subcontracting to put every idle tool to work on war orders. He believes that as much as 90 per cent of some prime contracts can be subcontracted.

Steel manufacturers were requested to limit their production of steel for shoe shanks to the three thinnest sections now made. A shoe shank is a sheet-steel stamping that reinforces that part of a shoe that supports the arch of the foot.

APRIL 16—Donald M. Nelson declared that war-plant workers should take vacations, but that they should be arranged so that production will not suffer.

Applications to buy new commercial vehicles were discouraged unless the cars would help win the war. More than 50,000 applications were received during the first month of the rationing plan.

Use of natural resins in certain paints and finishing compounds was restricted. One result will be rougher surfaces on playing cards and lead pencils.

Production of electric heating pads for home use was prohibited after June 30.

APRIL 17—The Director of Industry Operations assumed control of the allocation of heavy compressors and dry vacuum pumps. Crank- and flywheel-type horizontal units displacing more than 50 cfm., and all other types of reciprocating machines displacing more than 300 cfm., can neither be ordered nor delivered without explicit authorization, and war requirements will be served first.

The quota allotment of new passenger autos for March, April, and May was set at 120,000. From January 1 to March 31, cars released by local rationing boards totaled 41,000.

Donald M. Nelson told newspaper editors that the United States is now supplying all the United Nations with critical raw materials, many of the finished and semifinished goods needed for war production, and a large part of the arms and implements of war. In addition, it is arming itself.

It was ordered that no person may use more than 60 pounds of honey in any month of 1942 in the manufacture of products.

Regulations limiting the use of tung oil were applied also to its substitute, oiticica oil because of the failure of the season's crop of oiticica nuts in Brazil.

APRIL 18—Director of Defense Transportation Joseph B. Eastman announced a 12-point program to insure maximum utilization of existing local passenger transit facilities. Staggering of working, store, and business hours; diversion of bus traffic to street cars; control of street traffic to favor the movement of mass-transit vehicles; and use of school buses for general transportation were among the measures advocated.

Mr. Eastman refused to certify that a proposed 1,050-mile crude-oil pipe line from Wichita County, Texas, to Savannah, Ga., is necessary for national defense. The line would require 85,000 tons of steel and many engines and pumps.

APRIL 19—Owners of the nation's 5,000,000 commercial automobiles were urged to exercise rigid maintenance to conserve them. Rebuilding of worn parts was recommended because of the growing scarcity of replacements.

Thirteen firms that supply 95 per cent of the brass materials used for small-arms ammunition agreed to reduce their prices 1 cent a pound.

The OPA announced that every holder of a War Ration Book will be allotted not more than 5 pounds of sugar for the home-canning of fruits and vegetables.

APRIL 20—Total building construction in 1942 was estimated at $13,750,000,000, a 20 per cent increase over the previous high year, 1941.

Maximum prices of domestic and foreign wood pulp were frozen at levels prevailing for the past two years.

Rationing of sugar came nearer, with the distribution of millions of copies of instructions and forms. Our nation now uses 20,000 pounds of sugar a minute.

Upon assuming the chairmanship of the War Manpower Commission, Paul V. McNutt predicted that 13,000,000 additional war-production workers will be placed in jobs during the ensuing year. Anent the skilled labor shortage he said that for every skilled tool designer available 51 are needed. The ratios prevailing for some other occupations are: marine machinists, 22 to 1; ship carpenters, 7 to 1; aircraft riveters, 4 to 1.

APRIL 23—Further rationing of gasoline in the East was announced for May 15.

"Joe seems to have forgotten already that he painted himself into a corner of his kitchen about this time last week."

Let's Go Fishing

THE fact that 23,000,000 Americans go fishing in an average year justifies our publishing a brief article on angling in this issue. Any subject that interests such a large proportion of the general public merits attention. A good fish story—and we think ours is good—ought to serve as a spring tonic and soothe war-jangled nerves.

Fishing for sport is continually developing into a more exact science. Everyone likes the story of the small boy who, with the simplest of outfits, catches more fish than the city fellow who is literally weighted down with modern equipment, but that is not true anymore. Fish are not so plentiful in inland streams and lakes as they were a few years ago, and the number of fishermen has increased many fold. If it were not for the systematic stocking of watercourses, angling would soon become a dead sport in most sections of the country. In short, the competition is keener than it used to be, and, by and large, the better-equipped fisherman gets the most fish. It is true, of course, that they are generally skillful anglers, for "the better the workman the better his tools."

Numerous fishermen not only are meticulous about their tackle and sticklers about the proper angling technique but they are also prone to put their trust in scientific data rather than in "fisherman's luck." Every angler knows that at certain times "they are not biting," but it was only recently that anyone tried to find out why this is so and to work out a basis on which to forecast the periods of good and bad fishing. Now it is pretty generally conceded that the sun and moon exert subtle influences on the feeding habits of fish. Investigators have worked out sol-lunar tables that list the major and minor feeding periods for each day, and experience proves that they are remarkably accurate.

Along with this scientific approach to angling has come a vast improvement in tackle and equipment. Plastics, nylon, and other synthetics are making big inroads on older materials and, despite the fact that their first cost is sometimes higher, reduce the over-all cost of fishing because of their greater durability. Right now there is a shortage of hooks from Norway and England, of gut for leaders from Spain and Japan, of bamboo for rods from China, etc., but American inventiveness and ingenuity can be depended upon to tide the army of anglers over the war period. Like baseball, fishing is one pleasure that our nation does not want to forego.

Keep 'Em Running

DURING these times, when the national slogan is "Keep 'em Flying," it behooves plant engineers in charge of machinery to keep it running. This is vital for factories that are turning out war supplies, and it is equally important for others because they may not be able to get replacements for some machines and, if they are, it would reduce the war-production effort to just that extent.

Compressed air is depended upon for important operations in many plants, and in some of them it is a vital form of power. In all of them careful attention should be given to the compressors, the distribution lines, and the tools or machines that are air operated. They should be inspected more often than formerly and receive regular maintenance to keep them functioning properly and to obviate the necessity of making major repairs. In normal times the latter could be done on Saturday afternoons and Sundays; but under the 7-day weekly schedule now in force in most factories, machinery cannot long remain idle without seriously curtailing production.

There is an optimum pressure for the operation of most compressed-air tools and machines, and their effectiveness is seriously impaired if the pressure is materially lowered. Such a drop can come from various causes. The compressor may not be running right, or there may be too great a drain on it to enable it to keep the line pressure up. Oftentimes it does its part only to have leaks in the distribution lines waste much of the air and reduce the pressure below the point of maximum efficiency. So much has been written on this subject that it should not be necessary to mention it again; but there are still too many leaky pipe lines, and testing for tightness should be done regularly.

Another harmful influence is moisture in the compressed-air system. In tools and machines, it washes away lubricants, resulting in excessive wear with attendant sluggish operation. This may soon lead to costly repairs, or lost time. Aftercoolers, supplemented in some cases by traps and separators in the distribution lines, will reduce the moisture content below the danger point and pay for themselves quickly in many cases.

In Praise of Molasses

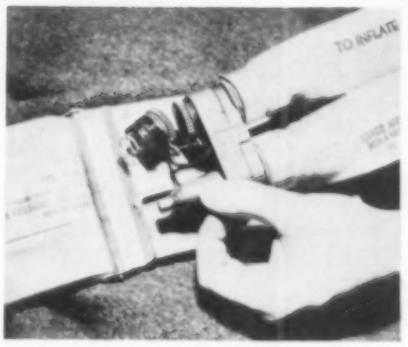
IN the days of sugar rationing that lie directly ahead, some Americans may perhaps turn to molasses to obtain some of the sweetness they crave. In that event, they will be improving their bodily health. In another era, people took sulphur and molasses as a spring tonic and apparently benefited by it, although they did not know why. Scientists have recently determined that molasses is rich in iron and calcium, as well as in vitamins of the B complex. These dietary items are especially helpful after the deficiencies of winter. Refined sugar, on the other hand, contains fewer minerals and vitamins than any food we eat.

Molasses, like honey, is rich in "invert" sugar, a noncrystallizing, syrupy mixture of dextrose and levulose. These sugars, in addition to their other desirable qualities, furnish abundant and immediate energy. Molasses has a distinctive, pleasing taste, and as it blends well with many other flavors it can be used in preparing many appetizing foods. So far, researchers have been unable to discover any reason for partaking of sulphur.

Danger of Electric Shock from Cords and Its Prevention

IN WET places such as mines, pumping stations, and washing plants, where alternating current is used for extension lighting, the danger of electric shock is always present. It can, however, be eliminated by equipping the cords with 50-watt, 110/6-volt transformers and 6-volt lamps, a practice that has been adopted by the Public Service Electric & Gas Company of New Jersey. The necessity of these protective measures was emphasized in an article in *Public Utilities Safety* published by the National Safety Council, and we quote from it because of the general disregard of the danger.

"There seems to be a belief among workmen that 110 volts is not harmful and can produce fatal shock only in cases where a man has a weak heart. This is not true. Tests have been conducted which show that when an electric circuit is completed through a wet contact, any voltage in excess of 12 volts is dangerous. Realizing the hazard that exists when work is performed in a wet or damp location that provides a perfect ground for the 110-volt circuit should extension lamps become defective, the electric generation department of the Public Service Electric & Gas Company in 1928 decided to have one of the local manufacturers design and develop a 110- to 32-volt, 50-watt transformer. During that year all 110-volt extension cords were replaced with the new 32-volt transformer. However, as a result of further experimentation, this transformer was rebuilt so that its secondary voltage was reduced to 6 volts, which is recognized as an absolutely safe minimum. It is now possible to procure 6-volt lamps with the standard base. Low-voltage transformers of this kind are being used exclusively about the property to eliminate electric shock."



LIFESAVER

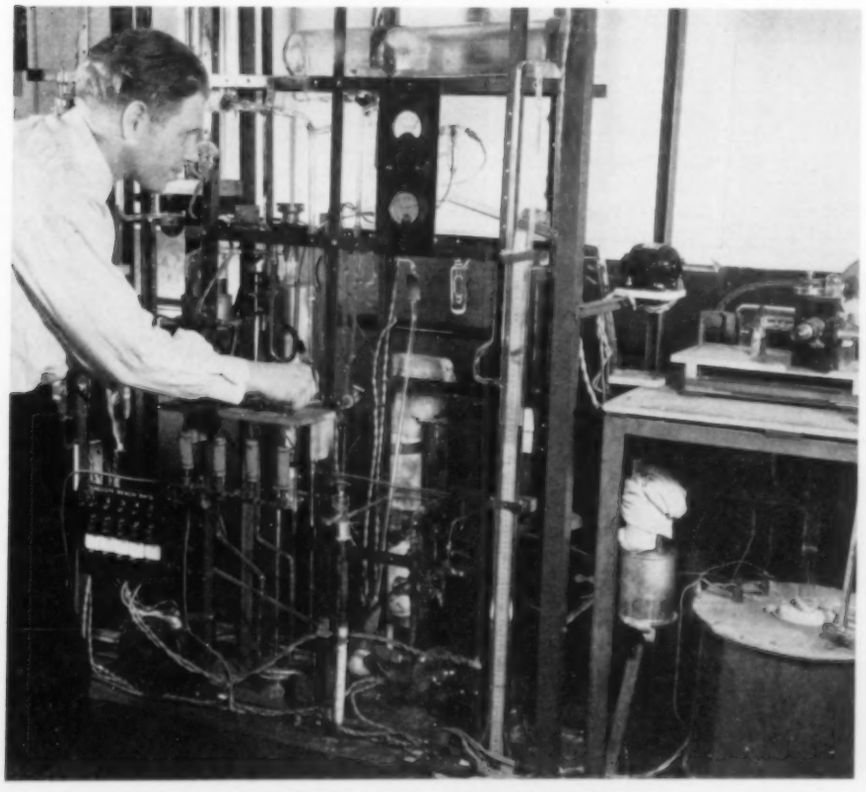
This lifebelt is manufactured for the nations's armed forces by The Firestone Tire & Rubber Company and is so compact that it can be worn around the waist without inconvenience under combat conditions. It is inflated by bringing pressure to bear on two common drugstore-variety carbon-dioxide cartridges, thus filling the belt with the buoyant gas. Normally it is worn folded, but under expansion it automatically opens, as shown in this picture.

Rust Weighed by Supersensitive Balance

ONE of the most sensitive weighing machines ever devised is being used by Dr. Earl A. Gulbransen of the Westinghouse Research Laboratories in connection with his studies of rust prevention. This balance, which is described briefly in the following paragraphs, measures its loads in weight units of ten-billionths of an ounce!

It is estimated that the damage to bridges, steel buildings, and machine parts by rust, tarnish, and corrosion amounts to $200,000,000 annually. In an effort to reduce this staggering total, Doctor Gulbransen is seeking new ways to protect steel and other metals against the destructive action of oxygen in the air. The special weighing machine developed for this work is sealed in one arm of a cross-shaped glass tube. The moving arm of the balance is made of quartz and is 6 inches long and $\frac{1}{16}$ inch in diameter. The fulcrum is a piece of fine tungsten wire which is stretched across a framework that is also of quartz. From one end of the moving beam is suspended a sample of steel half the size of a razor blade and from the other an equally heavy counterweight. The pointer of the balance moves so slightly when a layer of oxygen atoms forms on the steel that the movement can be observed only through a microscope. One layer is about ten-billionths of an inch thick, and there are enough atoms in just one thimbleful of oxygen for more than 65,000 such layers.

The weighing procedure is as follows: The piece of steel is polished and washed three times in alcohol before it is placed in the tube. That contact with air, brief as it is, is sufficient to deposit on it several films of oxide. With the metal in position, the tube is sealed; the air is withdrawn by vacuum pumps; and a small quantity of hydrogen is piped into it. Combined with the oxygen on the steel, the hydrogen forms free water vapor which is at once pumped out, thus leaving the steel surface clean. Next, a small amount of oxygen is admitted to the tube. As oxide forms, the metal becomes increasingly heavier, and the changes in weight are recorded every few minutes. It has been found that a single layer of oxygen atoms weighs about fifteen-billionths of an ounce.



FOREST OF GADGETS TO WEIGH SPECKS

Dr. Earl A. Gulbransen, research chemist of the Westinghouse Electric & Manufacturing Company, measuring rust and tarnish in units of ten-billionths of an ounce. The assembly of tubes, valves, and meters at the left controls vacuum pumps and gas tanks connected to the glass tube housing the sensitive balance that weighs atoms of oxygen forming on metal and causing corrosion. The complete weighing instrument is on the table at the right.

Reclaiming Leaky Castings

MUCH as timber is impregnated with preservatives to increase its life, so can castings that have become leaky through use be treated and thus made good for further service. This applies equally to iron, steel, bronze, brass, aluminum, nickel, and silver castings, claims the Bakelite Corporation, which has developed two sealing solutions for the purpose: BE-2106, which contains a filler that prevents shrinkage and is suitable for aluminum and other castings with somewhat open porosity, and BV-1845, a thinner mixture for castings of finer texture such as bronze, brass, nickel, and silver.

The procedure by which the work is done is as follows: First the casting is cleaned and all openings but one are closed with plugs or gaskets. Then it is filled with the proper solution, and air or hydrostatic pressure is applied to force it into the pores. The pressure, which may run as high as 250 to 500 pounds with heavy castings, is maintained anywhere from two minutes to an hour, depending on the porosity. To assure penetration in the case of metals of fine texture, it may be advisable to draw a vacuum on it before impregnation. Next, the casting is cleaned by rinsing it with denatured alcohol, and this is followed by a preliminary baking at 175°F. for an hour or more to volatilize the solvent in the solution. Polymerization of the resin is effected by further baking at 250–275°F. for from two to five hours, depending on the oven and the size of the casting. At the end of that period the resin is infusible and insoluble, and remains so.

It is claimed that castings so impregnated are not affected by cold or hot water and by steam or temperatures up to 400°F. However, while the inert seal is resistant to most chemical reagents, special treatment is sometimes needed to reclaim castings employed in the chemical industry. It is pointed out that the system might be used to advantage for castings that are under pressure while at work. By making them tight in the first place it would be possible to prevent minor leaks that are not discovered until the castings are in service.

Mechanical Watchman

HOW, instantly, to effect a complete blackout when an air alarm sounds at night, is a problem that is puzzling many municipalities. The question is how to switch off in and outdoor advertising signs, as well as lights left burning in individual establishments as a protection against burglary? Large concerns have watchmen on the job, but small places of business cannot afford them and depend on electric lights to safeguard their merchandise, equipment, etc. The answer is the photo-electric cell, and the idea of using it originated with Andrew Tessier who, together with his brother, conducts a modest machine shop in Schenectady, N.Y.

When war was declared, orders were issued to everyone in the community—including store owners, service stations, and the like, that all lights must be extinguished within five minutes after an air-raid warning. The Tessiers decided that the easiest way out of the difficulty was to dispense with illumination after the day's work; but the first night the place was left in darkness it was broken into. In trying to protect themselves and yet save the expense of a watchman, it occurred to Andrew that both could be done by means of the electric eye. He promptly had one installed at a second-story window, with the "eye" focused on a nearby street lamp and adjusted so that when that lamp is extinguished all the lights left burning in the shop are extinguished, and when the street lamp goes on again all the shop lights are switched on automatically. The system works; and for an expenditure of less than $50 the Tessiers have provided themselves with a dependable guard for the duration of the war.

Photo, General Electric Company

NEVER SLEEPS

Mounted in a second-story window where it can be focused on the nearest street lamp, the electric eye stands guard over the Tessier Brothers' shop, turning the lights off during a blackout and on when the "all clear "sounds.

TIRE RATIONING DOESN'T BOTHER HIM

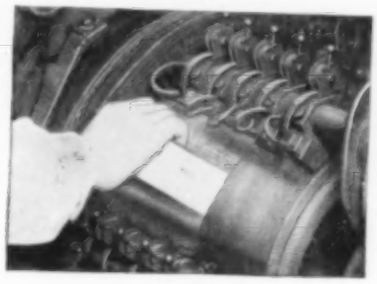
Perkins Battles, rural mail carrier of Randolph, Vt., is pictured here with his snowmobile. His auto is shod with tires that were discarded by a transport airplane. They have a cross-section width of 17 inches and fit a 16-inch wheel. Battles says the large tires enable him to travel through deep snow or mud without the usual difficulties. He uses the vehicle as shown during six months of the year, then changes to regular automobile tires.

Light-Weight Cherry Picker

FOR its own use in small tunnels and crosscuts, Silver King Coalition Mines Company of Park City, Utah, has developed a "cherry picker" that is light and compact so that one man can easily move it about. The steel framework consists of a 5-inch I-beam supported by A-shaped ends of 2-inch pipe with 1½-inch bracing and looks like an exaggerated sawhorse. Suspended from a 1-ton crawl traveling on the I-beam is a short air cylinder to the piston rod of which is bolted a 4-inch I-beam disposed lengthwise and carrying a chain at each end. When a car is spotted under the cherry picker, saddles, attached to the chains, are slipped over the ends of the underframe of the car and air is admitted to the hoist by opening a 3-way valve. The car is thus lifted without effort and is then pushed to one side by aid of the crawl. The over-all height and bottom width of the equipment are 7 feet 9½ inches and 9 feet, respectively.

Industrial Notes

To help keep motors and generators in service 24 hours a day, the Ideal Commutator Dresser Company recommends the use of its new commutator cleaning stone. It works while a machine is running, and is said to remove any excess film or brush deposits by simply holding it against the commutator and slowly moving it across the face. Five sizes, ranging from 2x2x2 to 4¾x2x½ inches, are available.



Nuplastic, a tough waterproof material that can be molded or spread by pressure of the fingers, is recommended for sealing and mending jobs of all kinds. It can be applied to any smooth, dry surface and is said to be especially suitable for repairing or altering wood or metal foundry patterns.

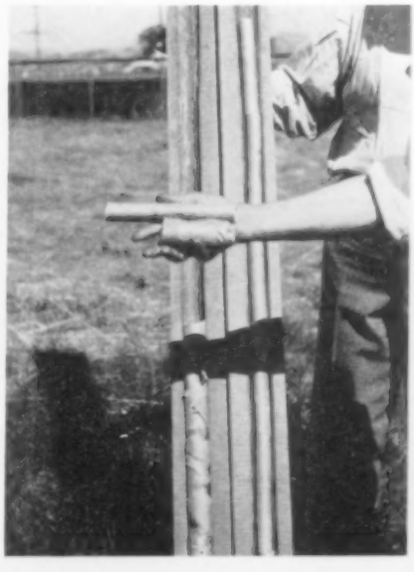
As a substitute for cork for low-temperature and roof insulation, the Owens-Corning Fiberglas Corporation is producing a material made of glass fibers and coated with asphalt. It comes in 12x36-inch blocks in three thicknesses—1, 1½, and 2 inches—and is compressed to a density of 6 pounds per cubic foot, giving it sufficient strength for self-supporting partitions. The insulation is said to be odorless, fire-resistant, and proof against insects and vermin. AE Board, as it is designated, can be sawed, using kerosene as a lubricant, and is fastened with treated-wood skewers.

For greater convenience, the Tempil Corporation is now offering its temperature-indicating chemicals for metals in stick instead of pellet form. The mark it leaves looks like chalk, but changes into a liquid streak the instant the metal reaches the required temperature, thus preventing overheating. The sticks are packed in individual tubes and are made to signal temperatures between 125 and 300°F. in 25° gradations and between 300 and 1,400° in 50° steps. Each Tempilstik indicates only one temperature and is good for 1,000 applications.

The State of Mississippi is kind to its motorists. The highway department operates a sweeper equipped with magnets to clear the roads of bits of iron that might damage tires. The trailer-truck carries three magnets—two in front and one in back—covering, combined, a strip 8 feet wide. Each magnet is approximately 3 feet long and 17 inches wide and is capable of attracting up to 4-inch nails about 7½ inches away from the center. For dirt roads or airplane landing fields, the units are hung 3 or 4 inches above the ground, permitting the magnetic force to penetrate the loose sand or gravel and to remove buried pieces of metal that might work their way up to the surface.

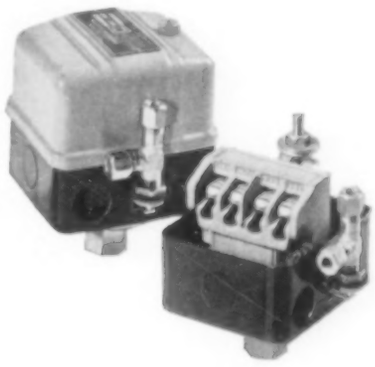
For electrical apparatus that are subjected to abnormally high temperatures The Sterling Varnish Company has produced a new insulating varnish under the designation of S-110. When baked at 175–200°C. (347–392°F.) it dries all the way through the deepest winding, it is claimed, and will withstand operating temperatures of 250°C. (482°F.) The film is mechanically strong, exceptionally adhesive and flexible, and retains these characteristics under adverse heat conditions.

Tamptite, an innovation in dynamite cartridges, has been announced by Hercules Powder Company. The dynamite is packed in a waxed-paper shell having a spirally disposed line of perforations that are located between layers of paper so that there are no direct tracks in the wall through which moisture might enter and contents leak out. When a charge is tamped in a bore hole, the cartridge unwraps slightly as the dynamite expands to fill the hole. Because of this feature it is not necessary to slit the container, as is now generally done, thus saving considerable time. The latter is not weakened sufficiently to make priming difficult; and it is said that Tamptite cartridges are capable of withstanding ordinary shipping and handling as well as do the conventional types. All Hercules explosives commonly used in mining, quarrying, contracting, underground work, etc., and ranging in diameter up to 1¾ inches, are available in the new shell.

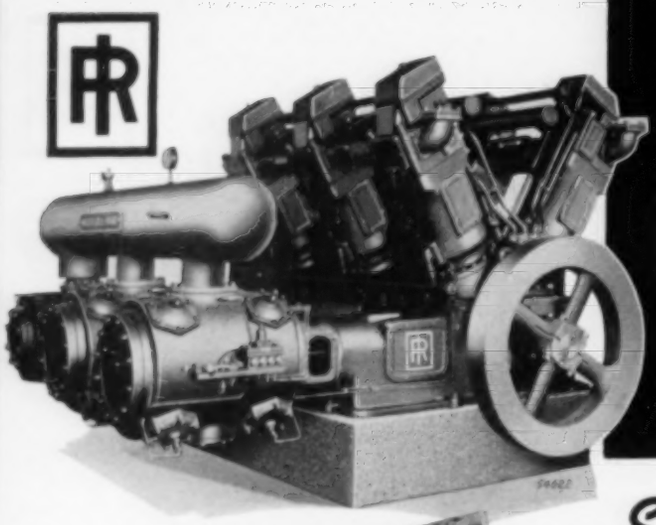


BEFORE AND AFTER TAMPING

A newly designed pressure switch for small motor-driven air compressors is offered by the Square D Company. In addition to performing the usual function of starting the motor when the receiver pressure drops and shutting off the current when full pressure is built up, the device incorporates a release valve which eases the starting load on the motor. This valve exhausts the high-pressure air which is trapped between the cylinder head and the check valve as soon as the current is turned off, with the result that the compressor always starts at no load. The entire assembly is compact and can be installed with ease and safety. A heavy block of porcelain serves as the line and motor terminal and has clearly marked compartments for the lead wires. Terminal screws are vertical in order to facilitate wiring. Interior parts are plated to prevent corrosion, and the actuating diaphragm is a high-grade fabric impregnated with a specially compounded rubber. Oil-resisting diaphragms also are obtainable. Class 9213A3 switches, as they are designated, are available with adjustable cut-out pressures ranging from 50 to 200 pounds per square inch and differentials from 15 to 40 pounds. The electrical ratings are: single phase, 1½ hp. 110 volts, 2 hp. 220 volts; single-phase alternating current, 1 hp. 550 volts; 2- and 3-phase alternating current, 2 hp. 110 volts, 3 hp. 220 volts, 1 hp. 550 volts; and for direct current, ½ hp. 110 and 220 volts.



Skin disorders resulting from bacteria or fungi in cutting, drawing, and core oils, etc., can be prevented, it is claimed, by the addition of a germicide in tablet form. The latter is suitable for use with both emulsified- and paraffin-base oils, being dissolved in water for mixing with the former and in alcohol for the latter.



Type XVO DIESEL-POWERED COMPRESSORS

Save Thousands of Dollars on Jobs Like These

With one gallon of fuel the XVO will compress 5600 cubic feet of air to 100 pounds pressure. That is 933 cubic feet for 1¢ when fuel costs 6¢ per gallon.

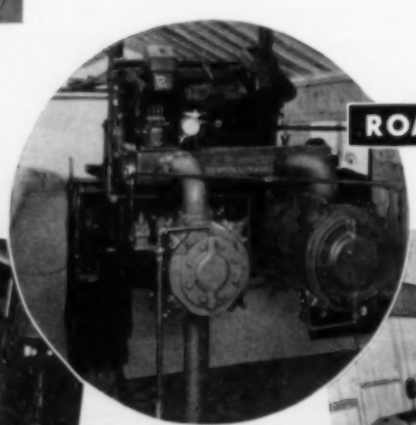
Such exceptionally low fuel costs reflect the advanced engineering features that have been built into this compact 4-cycle Diesel engine and the modern air compressor.

The proved reliability and ease of operation make the unit ideal for a wide variety of jobs. Owners everywhere tell us that it fulfills a long-felt need for a modern direct-connected Diesel engine driven compressor. Ask our nearest representative for further information, and for catalog 3072.

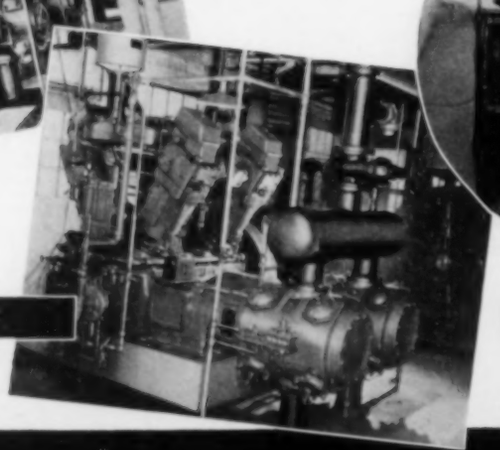
DRILL BOAT

CONSTRUCTION

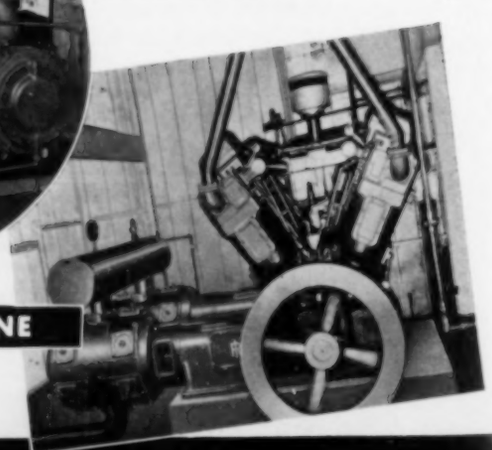
STONE QUARRY



ROAD BUILDING



FACTORY



SILVER MINE

Atlanta, Birmingham, Boston, Buffalo, Butte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Duluth, El Paso, Hartford, Houston, Kansas City, Knoxville, Los Angeles, Newark, New Orleans, New York, Philadelphia, Picher, Pittsburgh, Pottsville, Salt Lake City, San Francisco, Scranton, Seattle, St. Louis, Tulsa, Washington

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY

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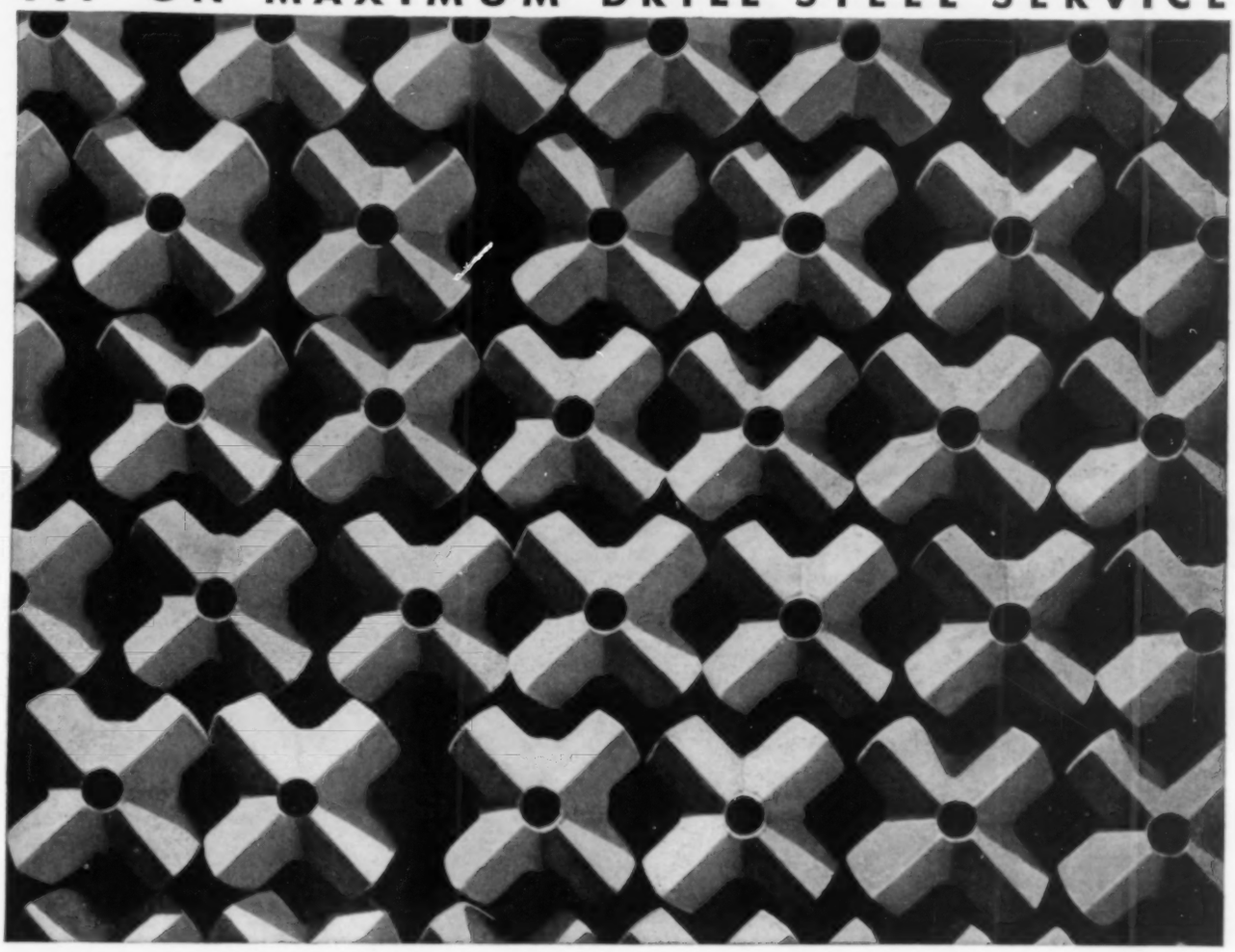
6-134

TIP ON MAXIMUM DRILL STEEL SERVICE



How to forge a bit... RIGHT

Now, at a time when there is a job for every pound of steel America can produce, all the greater need to handle your Hollow Drill Steel efficiently, make it deliver maximum service.

Here's how to forge a tool bit that will give you maximum service:

Heat the bar to between 1800 and 1950 deg. F. for forging, and discontinue forging when the bar has cooled to 1650 deg. F. Do not exceed 1950 deg. F. when heating or you may soften or burn the steel.

Always forge or treat the steel on a rising heat, being careful to let the heat penetrate to the center of the bar. Unless heated abnormally fast, the bar should be thoroughly heated through within a few minutes after the surface has reached the desired temperature.

In forging the bit, the hole should be opened to the full diameter with a pin. This is most important, since the upsetting necessary to form the wings will result in a partial or complete closure of the hole with consequent interference with the flow of air or water. When it is necessary to do any forging or upsetting of the threaded end of fabricated rods for use with detachable bits, the same forging practice as for the bitted end is recommended.

Bethlehem Superior Hollow Drill Steel

This dependable steel is playing a key part in the nation's war effort. It's driving tunnels, working in quarries, deepening harbors, preparing excavations for bridges, dams and buildings. America's ace construction men swear by Bethlehem Superior. They know it . . . like it . . . use it on job after job.

BETHLEHEM STEEL

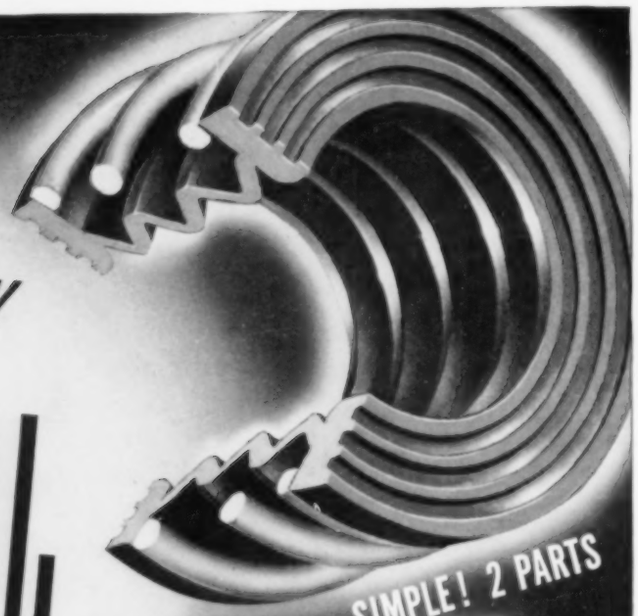
BETHLEHEM STEEL COMPANY

Here's that **NEW**

PUMP SEAL

by JOHN CRANE

☆



SIMPLE! 2 PARTS

EASY FLEXING

SEALS ON ENDS

Radical design has focused the attention of pump world on this new seal—a product of 25 years of packing progress . . . Simple! only 2 parts: bellows and spring; radial flexibility; assembled ready for installation . . . Seals on ends, not shaft . . . impervious to grease, oils, salt water, alcohols and anti-freezes . . . streamlines down to 2 parts—A new water pump seal is news! . . . especially when its revolutionary design cuts across all past ground and streamlined. Pump when all "dated" concepts such as sealing on the shaft go overboard—when control of every sealing factor is made absolute as in the new John Crane "fluid-tight" Bellows Pump Seal! . . . And the greatest news of all, are the all-time records already established. Pump designers, engineers and manufacturers are invited to submit blueprints. Sketches showing adaptations furnished without obligation . . .

CRANE PACKING COMPANY, 1800 (SAE) CUYLER AVENUE, CHICAGO . . . CRANE PACKING COMPANY, LTD., HAMILTON, ONTARIO, CANADA

Branch offices: Boston, Cleveland, Dallas, Detroit, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco, Tulsa.

Photo at left, top . . . **BELLOWS** is a series of accordion-like folds, connecting flanged ends. Because of seal's ability to flex and compress as a unit, parallelity of position is maintained. Thus pressure variation, misalignment, fan-thrust, torque or vibration set up by an unbalanced impeller are automatically accommodated. . . . Both bellows and flanged ends are one-piece special, exclusive John Crane synthetic rubber compound.

Photo at left, center . . . **SERRATED CONTACT FACINGS** are a series of concentric grooves and flat-faced ribs on both flanges; they effect seal at the washer and driving-base points.

Photo at left, bottom . . . **SPRING** is tempered, cadmium-plated steel stock. Other corrosion-resistant metals available.

Peak Production

KNOCKS OUT UNSTABLE OIL IN A HURRY!

Faster, faster clatter the drills . . . round after round. Can your compressor oil meet the requirements of today's demands for increased air supply? Don't wait for a failure to find out; give your compressors these outstanding benefits of Shell Compressa Oil:

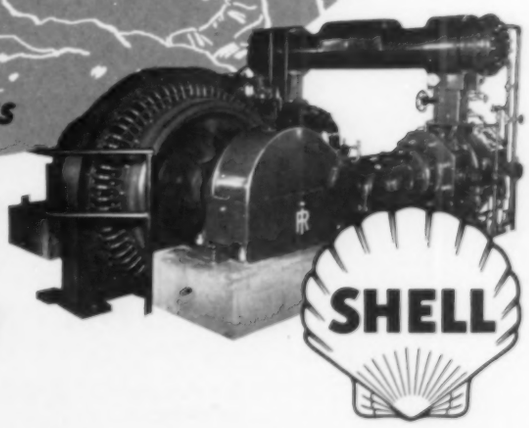
1. It is highly stable under severe operating conditions.
2. Does not break down at high-compression temperatures . . . prevents excessive formation of carbon deposits. Retains its lubrication qualities.
3. Helps prevent ring sticking and blow-by . . . keeps discharge valves working freely.
4. Reduces wear on all sliding and rotating parts.
5. Has high resistance to emulsification.
6. Assures low oil consumption by effectively sealing pistons.

If you're getting less, call in Shell now!

Keep your compressors on the job with tough

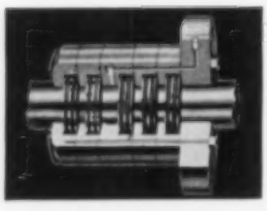
SHELL

COMPRESSA OIL



THE NATION'S WAR EFFORT

—a challenge to TEAMWORK!



COOK'S
METALLIC ROD
PACKINGS
for
ENGINES
(Steam—Diesel—Marine—Gas)
and
COMPRESSORS
Air—Natural and Refinery Gases—Process Gas—and for Recycling and Repressuring Units

★

There has been an approved type of COOK'S Packing developed for all service conditions backed by over 50 years' experience.

Wars are won by teamwork. The present one calls for the smartest, most wholehearted teamwork in our history—teamwork of our armed forces—of government and the public—of management and labor—and by no means least, teamwork between the maker and user of equipment.

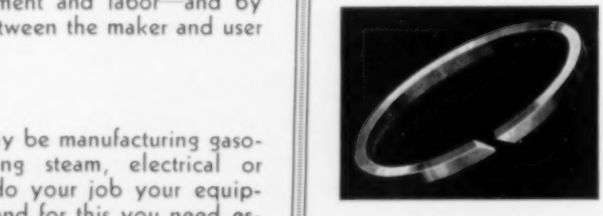
Your part in the war effort may be manufacturing gasoline—pumping oil—producing steam, electrical or compressed air power. To do your job your equipment must be kept running, and for this you need essential materials such as Piston Rings and Rod Packings.

★

For 54 years we have been making Piston Rings and Metallic Rod Packings for industrial size engines and compressors. Builders and operators alike recognize their outstanding excellence in keeping power up and maintenance down. Today we are supplying COOK'S rings and packings in large volume to meet direct government needs. At the same time, if we can help you in your effort, our products and our long experience are at your service.

★

So, if you need Piston Rings or Rod Packings—or have a problem pertaining to either—call or write our nearest office. You can count on us for teamwork to the limit.



COOK'S
GRAPHITIC IRON
PISTON RINGS
for
ENGINES
(Steam—Diesel—Marine—Gas)
and
COMPRESSORS
Air—Natural and Refinery Gases—Process Gas—and for Recycling and Repressuring Units

★

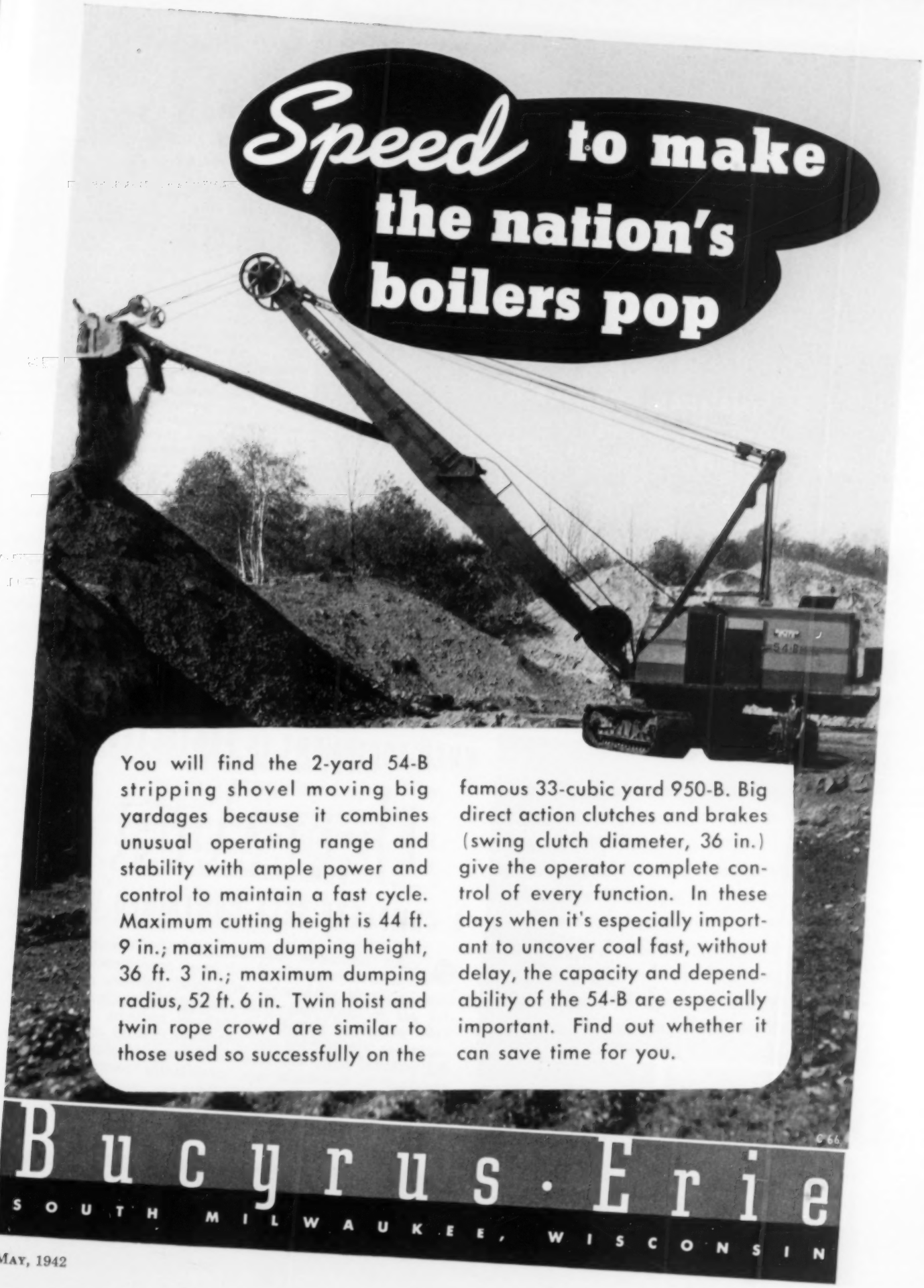
COOK'S Rings are available in all industrial engine sizes and types and in many special materials to meet unusual service conditions.

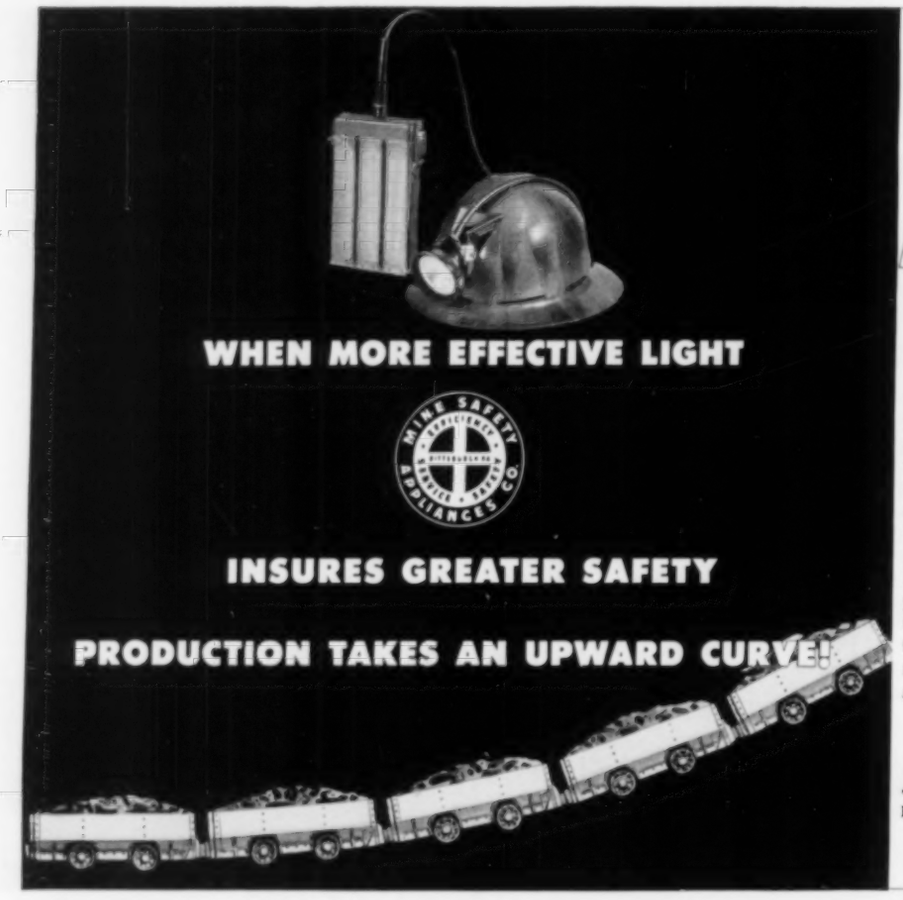
Sealing Pressures Since 1888

C. LEE COOK MANUFACTURING CO.

INCORPORATED

New York Cleveland Los Angeles Baltimore **LOUISVILLE, KY.** Chicago Tulsa New Orleans San Francisco


Speed to make the nation's boilers pop
You will find the 2-yard 54-B stripping shovel moving big yardages because it combines unusual operating range and stability with ample power and control to maintain a fast cycle. Maximum cutting height is 44 ft. 9 in.; maximum dumping height, 36 ft. 3 in.; maximum dumping radius, 52 ft. 6 in. Twin hoist and twin rope crowd are similar to those used so successfully on the famous 33-cubic yard 950-B. Big direct action clutches and brakes (swing clutch diameter, 36 in.) give the operator complete control of every function. In these days when it's especially important to uncover coal fast, without delay, the capacity and dependability of the 54-B are especially important. Find out whether it can save time for you.
Bucyrus-Erie
SOUTH MILWAUKEE, WISCONSIN



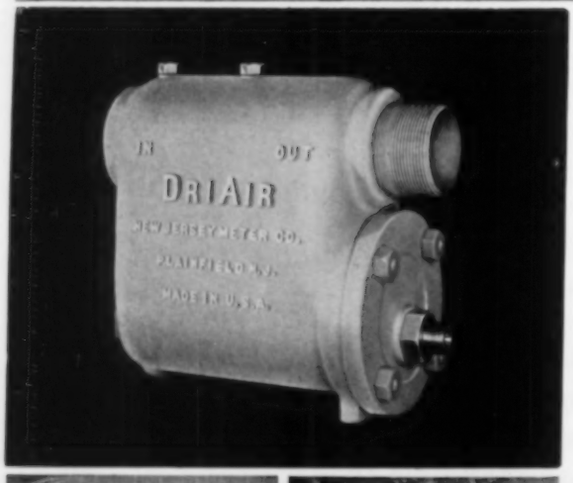
THIS year, with mining production climbing ever-faster under the stern stimulus of war, you'll find an interesting parallel between increased tonnage and the use of the Edison Lamp. Clearly shown in the higher output and lower accident rates of progressive operations are the advantages of *more effective light*, greater dependability and complete safety of the Edison Electric Cap Lamp—plus M.S.A. Skullgard's time-proved head protection and comfort. Good miners are better miners with these famous products . . . *better for themselves, and mining management, too!* Demonstrations on request.

MINE SAFETY APPLIANCES CO.

BRADDOCK, THOMAS and MEADE STREETS
PITTSBURGH, PA.

District Representatives in Principal Cities

GREATER PNEUMATIC EFFICIENCY



DriAir may be suspended from overhead piping without any other support.

A typical installation showing DriAir standing on the floor next to the wall.

SEPARATES • COLLECTS • DELIVERS

WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT

DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

Write for Bulletin DA which fully describes the construction and operation of the DriAir.

NEW JERSEY METER COMPANY
PLAINFIELD, NEW JERSEY

I want a Ingersoll-Rand MOBIL-AIR AIR POWER COMPRESSOR *on my jobs*

It's the same story everywhere . . . because now, more than ever before, users of portable compressors need the extra values that are available only in MOBIL-AIR. To *save time* . . . *fuel* . . . and *money* . . . you, too, will want a MOBIL-AIR.

Speeds Up Your Work . . . By means of its patented DRILL-MORE Regulator, the MOBIL-AIR maintains more uniform and higher average air pressures, giving you as much as 15% faster drilling with Jackhamers and similar air tools compared to portables equipped with conventional regulators.

Makes Almost Unbelievable Savings in Fuel . . . Combining the economies made possible by its new convertible engine, its new two-stage air-cooled compressor, and the DRILL-MORE Regulator, the MOBIL-AIR saves up to 40% in gasoline costs compared to the best previous Ingersoll-Rand model. Users everywhere say that MOBIL-AIR savings are almost unbelievable.

Uses either Gasoline or Fuel Oil . . . By a simple change of fuel accessories, you can always convert your MOBIL-AIR to take full advantage of the lowest-cost fuel in the particular area where you are operating, or to use whichever fuel is easier to obtain in case of fuel shortage.

Eliminates Delays . . . From end to end and from inside out, the MOBIL-AIR is an engineered unit with greater stamina built into it than any other portable Ingersoll-Rand has ever produced.

25 Additional Features are fully illustrated in bulletins available at any I-R office. (State the size compressor in which you are interested.)

★ **Three Working Speeds . . .** The patented DRILL-MORE Multi-Speed Regulator automatically selects the slowest and most efficient of three operating speeds that will maintain the required air pressure. It saves fuel, not only because it eliminates most of the usual idling periods which waste gasoline, but because the average working speed of the compressor and engine is slower and more efficient. Wear-and-tear is reduced. The machine lasts longer.

The above features are standard on all K-Series MOBIL-AIR Compressors. In the D-Series (60 and 85 cfm sizes) you get features particularly desirable for the smaller jobs.

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY

2-138

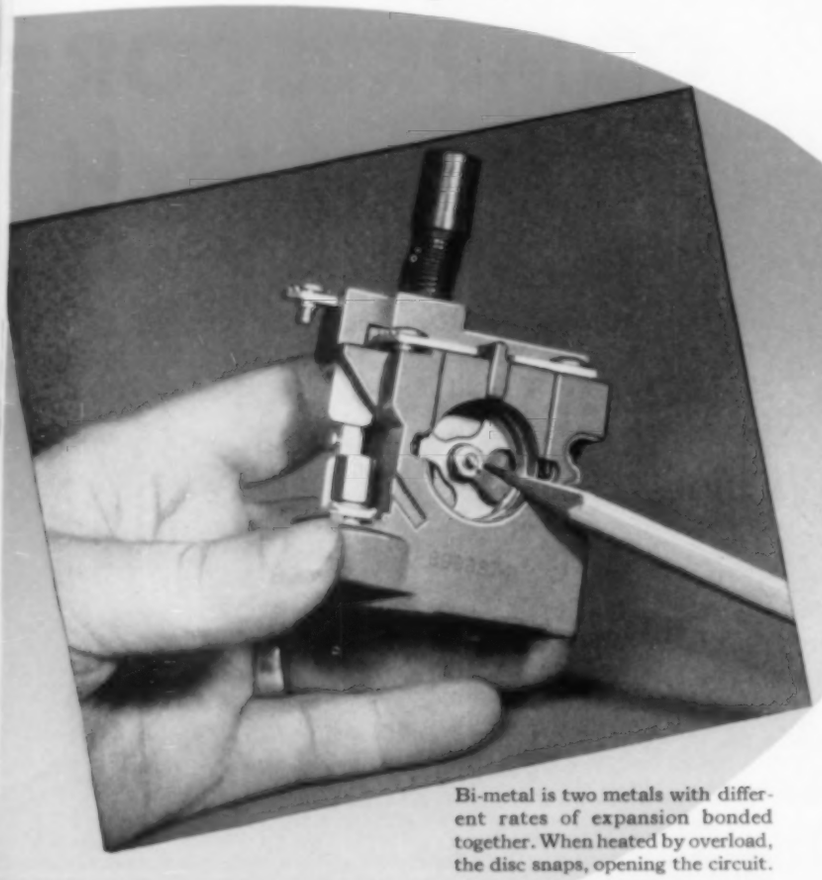
A Complete Line of Two-Stage Air-Cooled Compressors . . . 60 to 500 cfm (actual free air at 100 lb)

WE ALSO MAKE THE TOOLS THAT USE THE AIR

BI-METAL PROTECTION...

A WESTINGHOUSE FEATURE THAT MEANS

added protection FOR VITAL MOTORS



Bi-metal is two metals with different rates of expansion bonded together. When heated by overload, the disc snaps, opening the circuit.

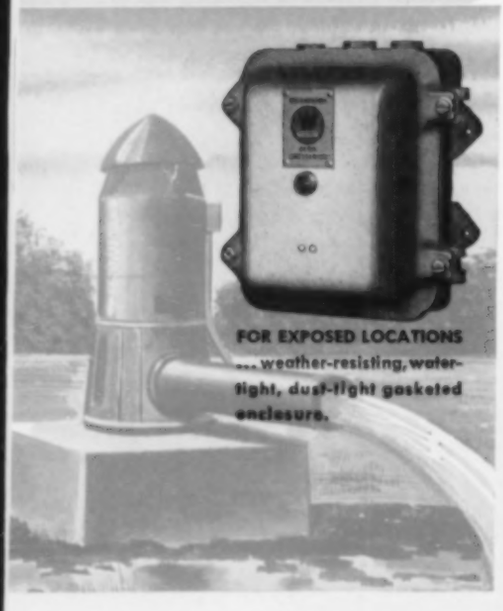
Motor protection that operates when it doesn't need to, means unnecessary delays in production. Protection that is prevented from operating when it should, means even more expense in damaged motors or machines.

The BI-METAL disc relay—a Westinghouse development—solves both problems. It acts with uncanny accuracy to permit temporary overloads, as when motors are started across the line, yet snaps the circuit open with rifle-bullet speed when dangerous overloads occur. Factory-calibrated, it is always accurate and tamperproof. Automatic or self-resetting of relay after an overload cuts production time losses to a minimum.

BI-METAL is a basic protective feature of Westinghouse motor starters and circuit breakers—you get it at no extra cost. Use it for the added, accurate protection it affords—specify Westinghouse protective and control equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

J-21185-A

THESE "De-ion" LINESTARTERS MEET SPECIAL REQUIREMENTS

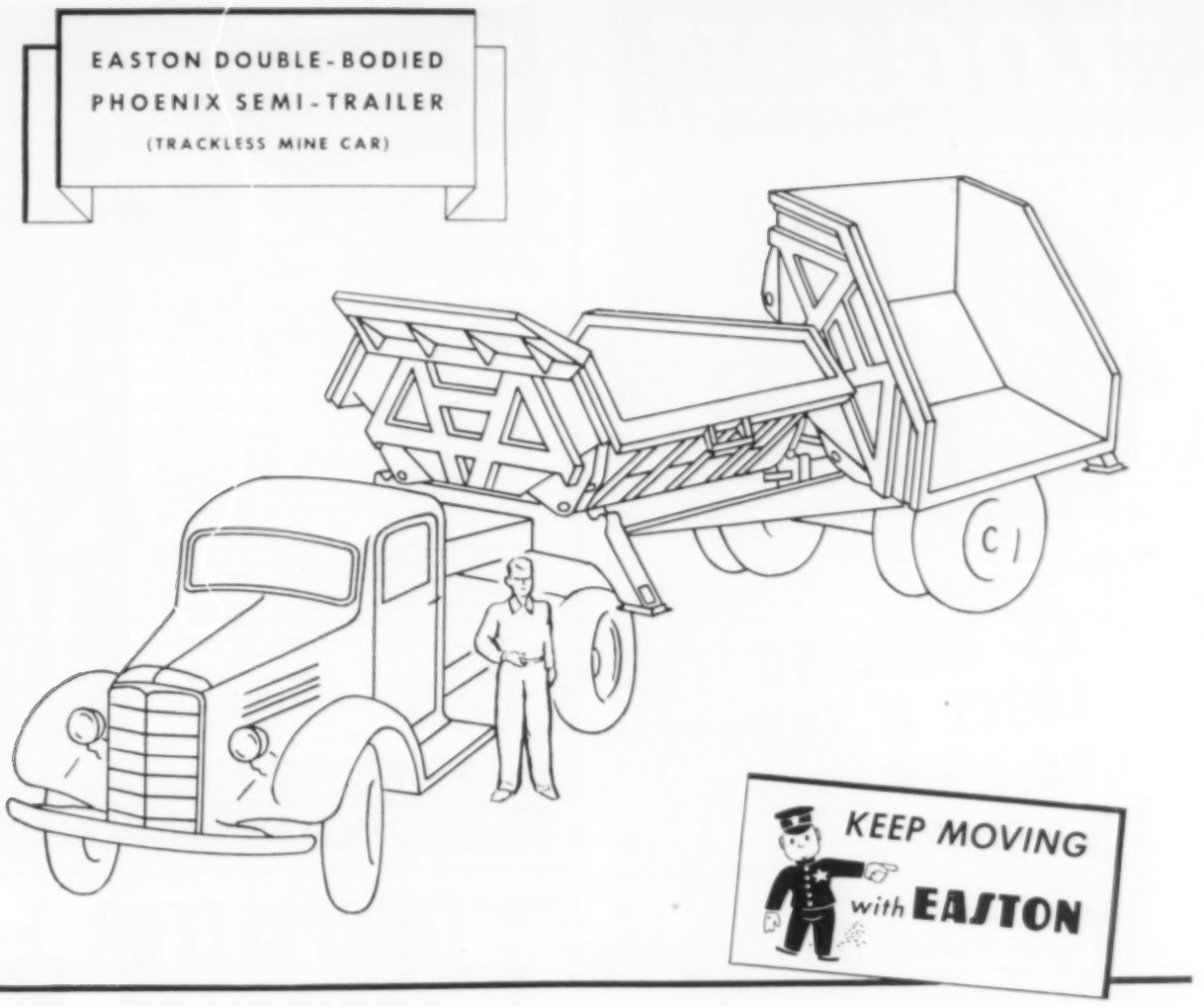


FOR EXPOSED LOCATIONS ... weather-resisting, water-tight, dust-tight gasketed enclosure.

FOR ATMOSPHERES CONTAINING EXPLOSIVE VAPORS... Class I, Group D hazardous locations.

FOR ATMOSPHERES CONTAINING EXPLOSIVE DUSTS. (Class II, Group G hazardous locations) Ground-fitted cast-iron enclosure.

Westinghouse



Problem: Big Load, Small Hopper

The problem was to haul a big load from the shovel to be dumped into a small hopper opening. To save fuel, tires and other haulage costs it was found desirable to use Semi-Trailers carrying comparatively large loads. But 17 tons entering the small hopper in one discharge would choke the crusher.

To meet requirements, the container, which would normally be a body of 17 tons capacity, or larger, was divided into two sections each of which will be dumped independently. The half-loads discharged will be easily handled by the crusher, while the operator benefits from all the advantages of Easton Semi-Trailer Haulage . . . including high speed, low costs, and big payloads.

A new idea? No. This unit is now being built for a Southern producer. But, in principle, it was blueprinted at Easton several years ago. It's the new application and the sound engineering which make it interesting. Also, it serves to illustrate how an Easton Survey, tapping a limitless reservoir of quarry haulage experience, might help you. That is why we urge our friends to let Easton Engineers study their problems now and plan ahead for the future.

Our first job today is to meet wartime handling requirements. Our production facilities are turned to that effort. But there's no priority on ideas. Easton experts will go all out to help you.

EASTON

CARS · SEMI-TRAILERS · TRUCK BODIES · FOR QUARRY SERVICE

EASTON CAR & CONSTRUCTION CO., EASTON, PA.

"LOGAN"

AIR EQUIPMENT

AS APPLIED TO LODGE & SHIPLEY No. 3A DUOMATIC LATHE ★ ★ ★ ★

This Lodge and Shipley Duomatic Lathe is set up for rough turning the ogive after nosing operation on 155-mm. shells. The headstock is equipped with a "LOGAN" Model "R" Double Acting Rotating Type Air Cylinder to supply gripping pressure to the "LOGAN" 3-Jaw Compensating Chuck. The tailstock is equipped with a "LOGAN" Model "A" Double Acting Non-Rotating Type Air Cylinder. In addition, this Lodge and Shipley Lathe is equipped with a "LOGAN" Reducing Valve, Lubricator and Pressure Gauge Unit and a "LOGAN" Model "H" Foot Control Valve. This "LOGAN" Air Equipment provides rapid, positive action and rigid support of the work. Let "LOGAN" Representatives and Engineers make recommendations on your problems.

LOGANSPORT MACHINE, INCORPORATED
920 PAYSON ROAD LOGANSPORT, INDIANA
Manufacturers of Air and Hydraulic Devices, Chucks, Cylinders, Valves, Presses and Accessories

EFFICIENCY 99% Plus

This 2-Way Separator insures clean, dry, oil-free COMPRESSED AIR

BECAUSE the Johnson-Gast Separator combines two of the most efficient principles of separation—expansion and change of direction—it removes more than 99% of all the trouble causing water, dirt and oil from compressed air.

The simple, compact design that achieves this unusual efficiency is shown at right. The entering air is first allowed to expand slightly, precipitating most of the moisture. Then it rushes through the "thousand baffles"—a maze of coarse wire mesh—changing direction of flow abruptly many times, and surrendering the remaining particles of moisture and dirt.

Team mates of the Johnson-Gast Separator are the Aftercooler—pictured as installed with an angle type separator—and the Oil Absorber. The Aftercooler condenses all moisture vaporized by the heat of compression. The Oil Absorber is used where every vestige of oil must be removed, as in paint spraying.

FOR USE ON STEAM LINES, TOO

Write for Bulletin

THE JOHNSON CORP.
830 Wood Street,
Three Rivers, Michigan

JOHNSON-GAST
SEPARATORS • AFTERCOOLERS • OIL ABSORBERS

COMPRESSOR EQUIPMENT

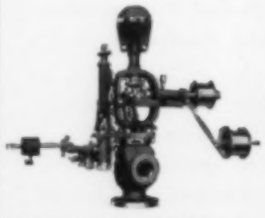
STURDY • SOUNDLY DESIGNED

JARECKI VALVES

Sizes and types to meet every condition, each soundly built, perfectly threaded and individually tested.

ERIE UNLOADER

Maintains constant pressure by governing inlet of compressor. Loads and unloads without shock or strain.



ERIE GOVERNORS

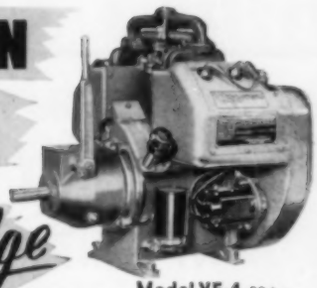
For steam engines, pumps or compressors. For speed control only or for combined speed and pressure control.

JARECKI FITTINGS

Air-furnace malleable fittings . . . close-grained, cast iron fittings, all with perfect threads. A complete line.

JARECKI Manufacturing Co.
ERIE PENNSYLVANIA, U.S.A

WISCONSIN
HEAVY-DUTY Air-Cooled ENGINES *Come of Age*



Model VE-4, 22 hp., 4 cyl., V-type Engine. Other types and sizes: 1 and 4 cyl., 1 to 35 hp.

"Old enough to vote", in terms of continuous production and development, Wisconsin heavy-duty air-cooled engines have also definitely come of age from the standpoints of industrial recognition and acceptance.

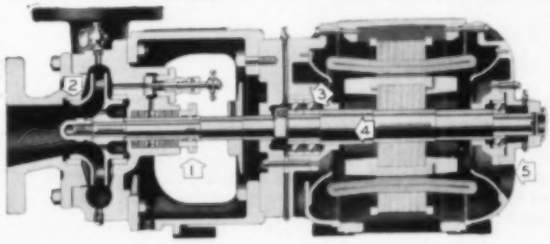
It has taken the hard proof of service, under the most trying operating conditions, in many lines of industry and power applications . . . to convince designing engineers, equipment manufacturers, and tough-skinned users that AIR-COOLED ENGINES, properly designed and built, cause less trouble and provide higher productive capacity than any other type of internal combustion unit within 35 hp. limits.

More than 300 machine manufacturers use Wisconsin Heavy-Duty Air-Cooled Engines as standard power equipment . . . covering your field as well as many others.

MOST POWER Per POUND

WISCONSIN MOTOR Corporation
MILWAUKEE, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

THE MOTORPUMP IS BUILT RIGHT

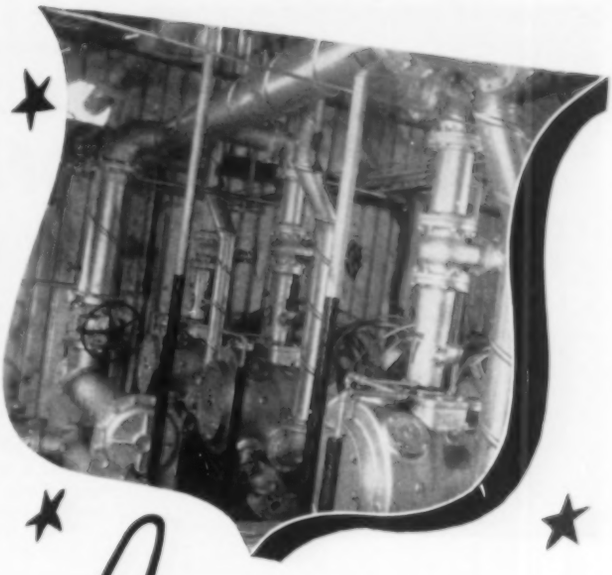


The Motorpump is a heavy-duty unit built to give many years of trouble-free service. Some of the features which make this possible are:

1. A split stuffing-box gland plus ample space makes the pump easy to repack and encourages proper attention on the part of the operator.
2. Renewable casing rings reduce leakage to a minimum and allows the original high efficiency of the unit to be restored after a number of years of use.
3. Ball bearings are used. These are larger than are found in a standard motor in order to carry the combined pump and motor loads. A cartridge-type bearing housing excludes dust and moisture.
4. The shaft is oversize. This makes a smooth-running unit with minimum shaft vibration, reduces air in the pump and stuffing box trouble.
5. A standard motor of well known make is used. Motor service is available at the manufacturer's shop in all parts of the country.

Ingersoll-Rand *Cameron Pump Division* 11 BROADWAY, N.Y.

B-59



Are your ★ PIPE REPLACEMENTS *Helping Win the War?*

● This is no time to waste vital steel. That's why pipe users everywhere are depending on Naylor Light-Weight Pipe for replacements.

Here's the one light-weight pipe that's built to do jobs normally requiring heavier-wall pipe. The exclusive Naylor Lock-seam Spiralweld construction gives you a combination of strength, leak-tightness and safety found in no other light-weight pipe. It not only saves vital steel, but saves you money on the job at the same time.

Sizes from 4" to 30" in diameter with all types of fittings and connections.

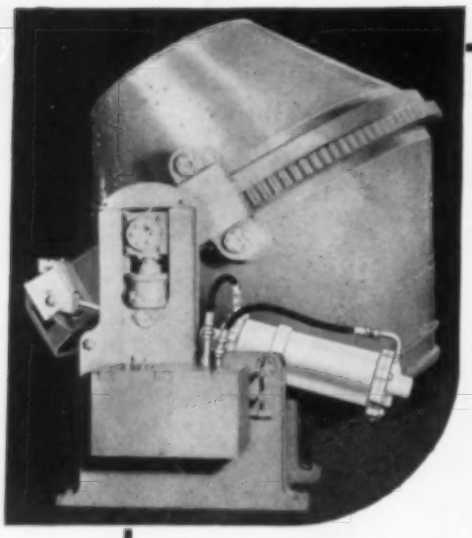
APPLICATIONS

Naylor Light-Weight Pipe is ideal for air lines, de-watering pipe, hydraulic mining, ventilating pipe, high and low pressure water lines, diesel intake and exhaust lines, dredging pipe, sand and gravel conveying lines.

Write for catalog or send specifications for quotation.

NAYLOR PIPE COMPANY
1245 EAST NINETY-SECOND STREET
CHICAGO, ILLINOIS

NAYLOR LOCKSEAM SPIRALWELD PIPE



New T. L. Smith 56-S Tilting Mixer equipped with NOPAK Model F Heavy Duty Air Cylinder with Trunnion Mounting to provide oscillating movement.

Every 2 Minutes (OR LESS)

NOPAK Heavy Duty CYLINDERS

Tilt GIANT SMITH Mixer Drums

This application of NOPAK Heavy Duty Air Cylinders illustrates their ready adaptability to a wide range of power movements. In this case low-pressure air power is used to tilt heavily laden concrete-mixer drums every 1½ to 2 minutes, hour after hour and day after day.

Built-in, self-regulating air cushions, in the cylinder heads, cushion the tilting action, eliminate shock and vibration. The result is smooth, speedy performance, high production, freedom from maintenance expense and a prolonged life of strenuous heavy duty service for the tilting mechanism.

Certainly, cylinders which meet the high T. L. Smith standards of design, construction, efficiency and long-lived dependability are worthy of your consideration.

Write for Bulletin 82-A.

NOPAK Air and Hydraulic Cylinders are available with either Adjustable or Self-Regulating Cushionheads in 6 Standard Mountings, in Regular or Heavy Duty Types.

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408 pages, 80 illustrations. Flexible, Morocco binding, gold-edged.

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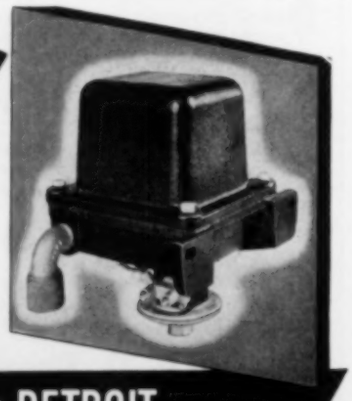

● The **CLASS 9013 TYPE AR** switch is built for use in Class I Group D hazardous locations. Top pressure 225 lbs.—standard air compressor settings—with or without release valve. Ratings are 2 H.P. 110 V., 3 H.P. 220 V. single phase and 5 H.P. 220-550 V. polyphase.

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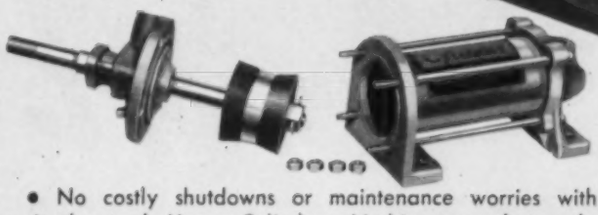
Hanna Cylinders

DEPENDABLE

Power

TO PUSH, PULL, OR LIFT...

on 1001 Jobs



• No costly shutdowns or maintenance worries with simple, sturdy Hanna Cylinders. Nothing wears but packings that are quickly replaced. The unique strain rod and flange construction permits piston removal without complete dismantling. Four nuts come off — that's all!

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Air and Hydraulic
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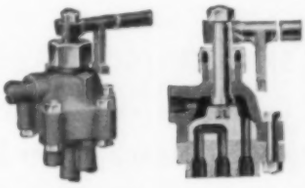

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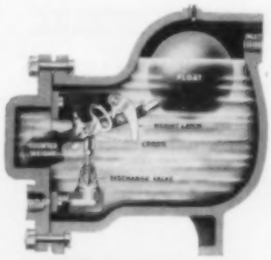
Air Control
VALVES *are Always*
Dependable 2, 3 and 4-Way Flat Disc Type, for single or double acting air, steam, water or oil cylinders, etc. Non-corrosive metals used in all vital parts. Sizes ¼" to 1½".



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"JR" TRAPS
Assure Automatic
Drainage of water and oil from Air Tanks, Receivers, Aftercoolers, Separators, etc. One body size—½", ¾" or 1" inlet—½" outlet. Pressures to 125 lbs. Other traps for pressures to 1500 lbs. Bulletin No. 941.

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Compressor Intake	☐	High pressure steam blow-off	☐
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MAXIM SILENCERS

SPEED SPEED SPEED...

THE SENSATIONAL NEW

HERCULES DYNAMITE CARTRIDGE SHELL

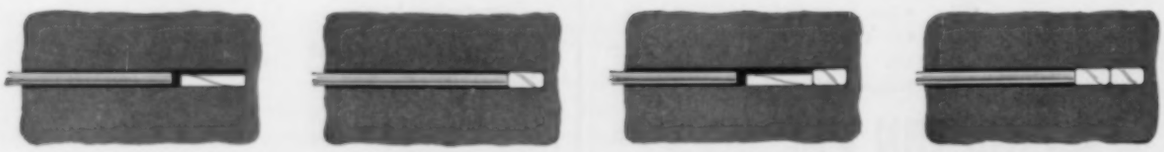
SPEED IN PREPARATION. No time lost in slitting cartridges. Just put the regular size cartridge in the hole and tamp.

SPEED IN TAMPING. There is no spillage of powder and no mess, because concentration of charge takes place *inside the wrapper.* Thus, loading is simple and quick—even in uppers.

SPEED IN OUTPUT. Tamptite concentrates the charge where you want it, which means better breakage of material, easier handling, faster production. Ask Hercules for Tamptite cartridges on your next dynamite order.

HERCULES POWDER COMPANY
INCORPORATED
932 KING STREET • WILMINGTON • DELAWARE

A QUICK LOOK AT TAMPTITE IN ACTION!



The regular-size cartridge goes in the bore hole. Note the space to be filled.

Pressure from the tamping rod compresses the powder to fill the space.

Another cartridge goes in—Compaction takes place inside the wrapper.

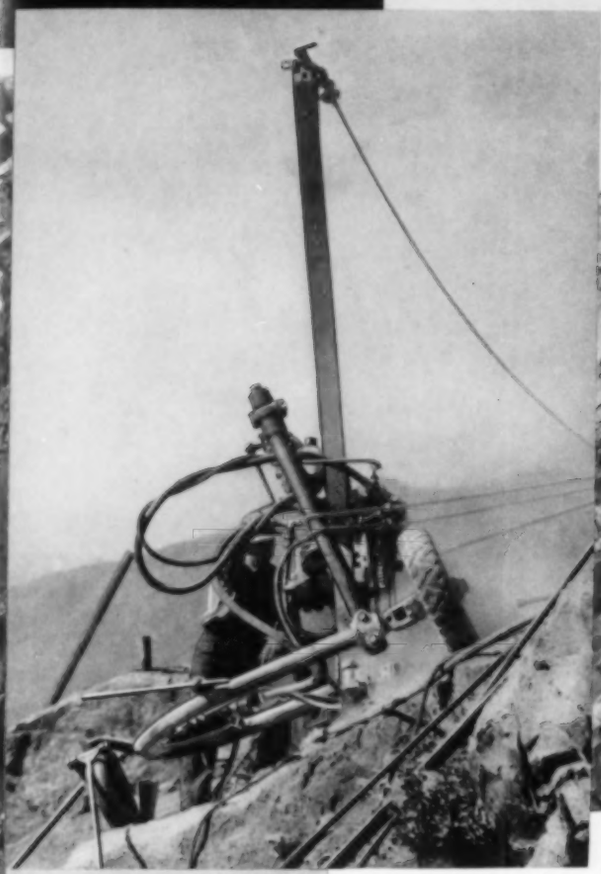
The charge is concentrated for better blasting results.

A-85

FM-2

FLEXIBILITY and DEEP-HOLE DRILLING POWER

Save time and money



One of 42 FM-2 Wagon Drills used on this job. The ease with which they can be set up, regardless of the ground, speeds up the work.

This quarry lies at a 43° angle. The flexibility of the FM-2 Wagon Drill cuts drilling costs. A small I-R air hoist mounted on the unit moves it up and down the incline.

The flexibility of the FM-2 Wagon Drill permits its use in all kinds of ground. Holes can be drilled at any angle—wherever you want them. A fast, convenient, portable method is thereby provided for using the powerful Ingersoll-Rand X-71 WD drifter drill. Twenty-foot steels are handled easily. Set-up time is reduced and time spent changing steels can be cut in half, so that more footage is drilled in a shift.

The X-71 WD drill used on the FM-2 has been developed especially for wagon drill service. The piston has a long stroke. It hits a heavy hammer blow which has a unique follow-through characteristic so essential for deep-hole drilling. In addition, the drill has powerful rotation and is capable of blowing holes easily to great depths.

Performance records from countless jobs prove that this combination of the specially designed X-71 deep-hole drill and the highly flexible FM-2 three-wheel mounting drills more feet of hole, day in and day out.

SOLVE YOUR DRILLING PROBLEMS WITH IR JACKBITS

KEEP 'EM DRILLING

Ask your supplier for an oil that meets I-R Specification 433 —the new rock drill lubricant developed by Ingersoll-Rand.

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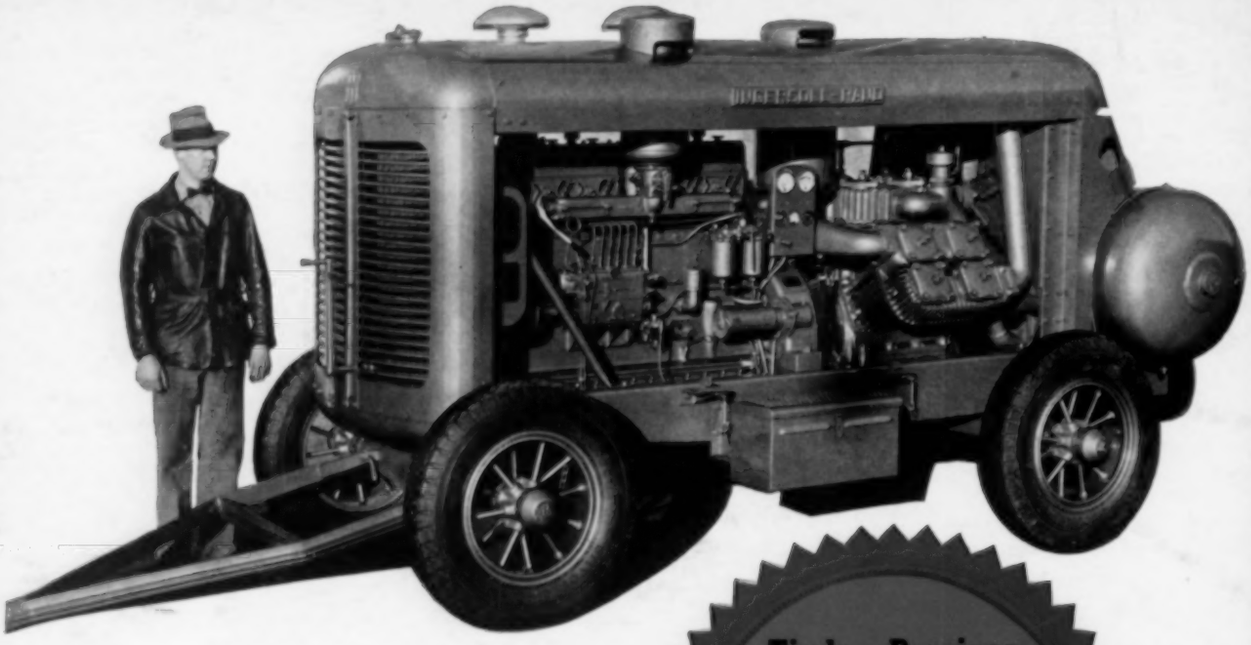

Ingersoll-Rand K-500 (500 c.f.m.) Two-Stage, Air-Cooled, Portable Compressor. Compressor crank shaft mounted on Timken Bearings.

Timken Bearings give air compressors full anti-friction efficiency for Victory and post-victory problems.

Whenever you may be considering the purchase of an anti-frictionized compressor, make it a point to investigate the *kind* of anti-friction bearings used. If they are Timken Tapered Roller Bearings you will be sure of getting every anti-friction advantage it is possible to receive.

That means more than friction elimination; it means in addition, full protection against radial, thrust and combined loads plus preservation of alignment of moving parts. These benefits combine to improve performance, reduce maintenance, extend compressor life.

Buy to help obtain victory—but don't overlook the conditions you have to meet afterwards.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

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BUY UNITED STATES DEFENSE BONDS & STAMPS

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